Electronics In The New Ford Falcon

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AUSTRALIA'S DYNAMIC ELECTRONICS MAGAZINE

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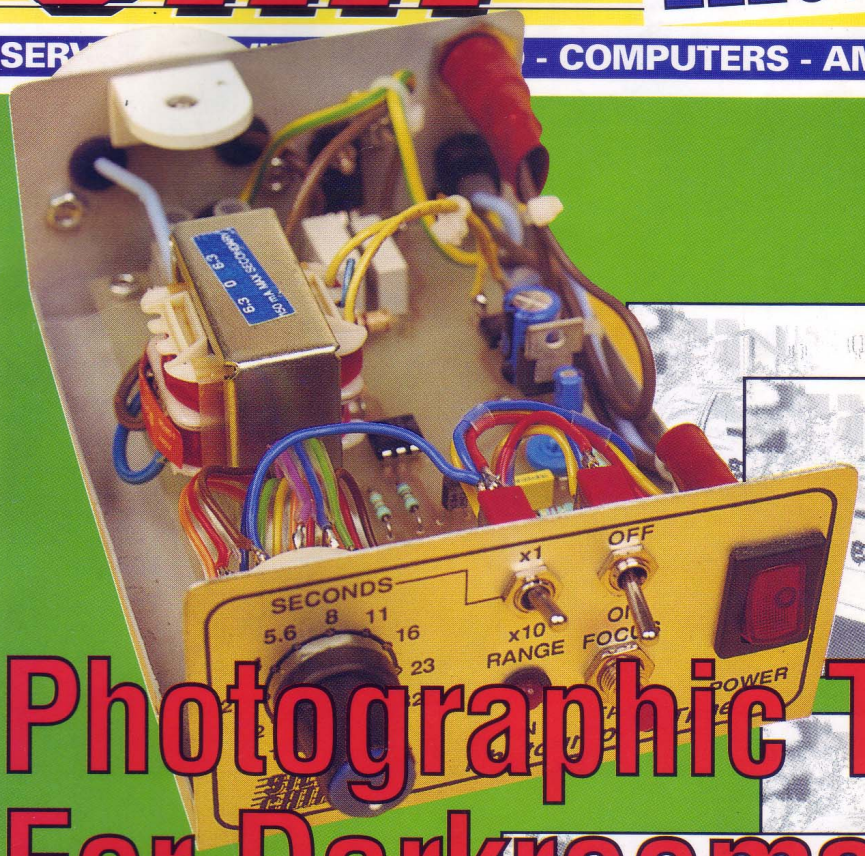

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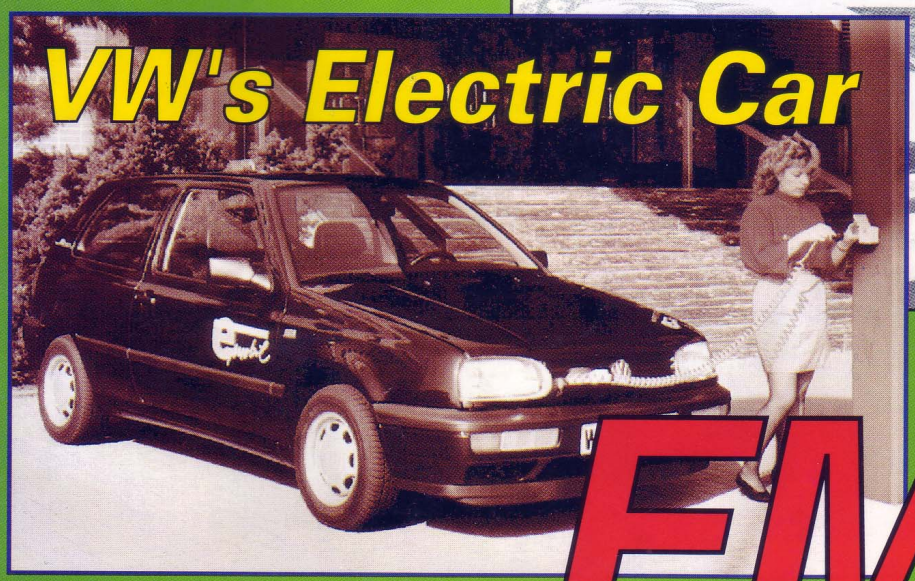

VW's Electric Car

FM RADIO TRAINER

SILICON CHIP

VOL.8, NO.4; APRIL 1995

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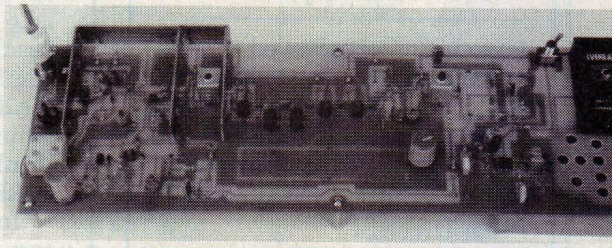

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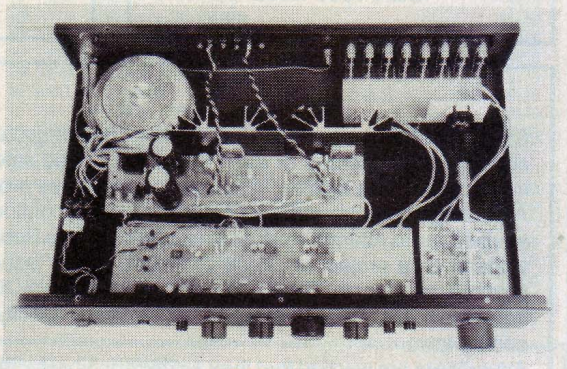

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Printing: Macquarie Print, Dubbo, NSW.

Distribution: Network Distribution Company.

Subscription rates: $49 per year in Australia. For overseas rates, see the subscription page in this issue.

Editorial & advertising offices: Unit 34, 1-3 Jubilee Avenue, Warriewood, NSW 2102. Postal address: PO Box 139, Collaroy Beach, NSW 2097. Phone (02) 979 5644. Fax (02) 979 6503.

ISSN 1030-2662

PUBLISHER'S LETTER

The Gordon Dam must not be emptied

It could only happen in a rich democracy: this recent proposal that the Gordon Dam in Tasmania should be emptied so that the original Lake Pedder can be restored. To put it bluntly, this is environmentalism gone crazy. I well remember writing an editorial in the June 1982 issue of "Electronics Australia" opposing the then proposed Gordon River dam scheme. This seemed to be a completely unnecessary scheme and one which was eventually stopped by the Federal Government in 1984. However, the Gordon Dam which flooded the original Lake Pedder is a much larger scheme which was completed in 1976. It was described in detail in the February 1991 issue of SILICON CHIP, as part of the popular series entitled "The Story of Electrical Energy" by Bryan Maher. At present, it has an installed generating capacity of 432 megawatts and is the major component of Tasmania's electricity supply.

Now I don't really think that the dam will be emptied but, in today's topsy turvy world, you never know what crazy scheme might succeed. So let's look at the proposal objectively. Sure, the original Lake Pedder was a pleasant enough lake although the only aspect that made it unusual was the salmon pink sand beach which showed when the water level was down – when the water level was high, the beach was not visible. Offsetting the subtle colour of the sand was the dirty brown colour of the water, a result of tannin leached from the nut grass which is prevalent in the catchment region. Actually, the water looks like a cola drink. Very few people ever saw the original lake since it was accessible only to trekkers or by plane (which had to land on the beach).

Today, we have a much larger body of (still brown) water which is visited by tens of thousands of tourists a year. If it were to be emptied, it would be a financial and environmental disaster. Not only would Tasmania lose a substantial portion of its electricity generating capacity but all the tourist dollars produced by this major attraction would vanish.

And how would all the vegetation in the area now covered by water (260,000 square kilometres) be restored? Would the dam wall with its 280,000 tonnes of steel and concrete be demolished and disposed off? What about the two other dams in the scheme which also raise the water level? And what about the very expensive generating plant? Would that be scrapped? And how would Australia then stand in its attempts to reduce carbon dioxide emissions in the years to come, if hydroelectricity has to be replaced by fossil fuels? How would Tasmania cope for water and electricity in the next drought?

These questions and many others have very unsatisfactory answers. Or very expensive answers. Really, the whole proposal is crazy and should be dismissed out of hand. Australia may be a rich democracy but we aren't that rich and nor, I hope, are we that silly!

Leo Simpson

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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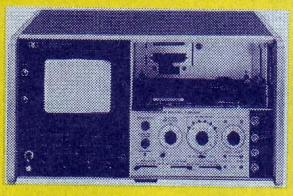

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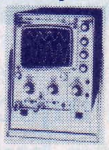

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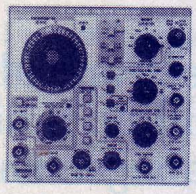

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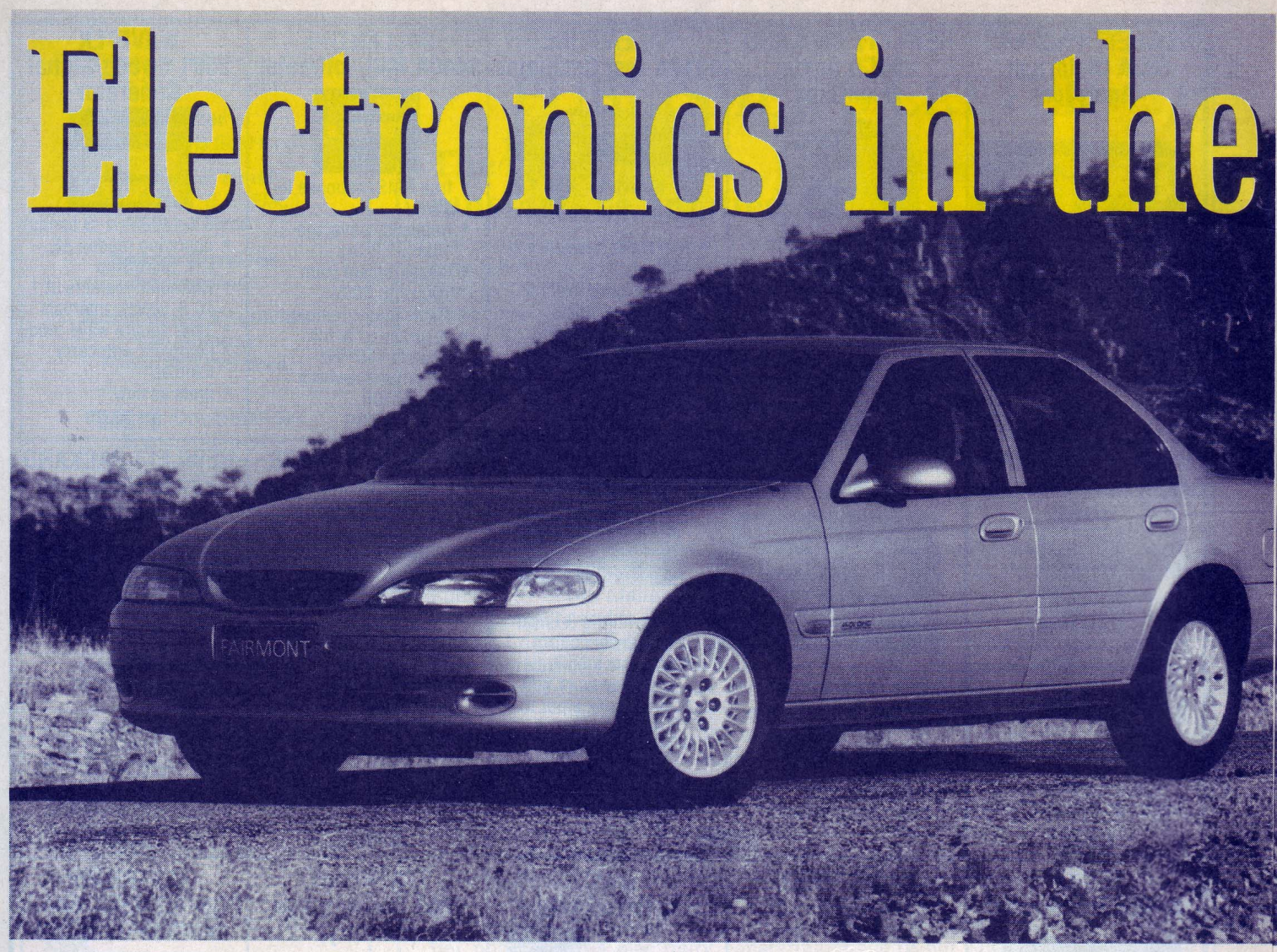
Electronics in the



Pt.2: engine management secondary control

Electronically controlled fuel injection & ignition timing is now common but the engine management system can also be used to control other functions. The latest Falcon range also uses electronic control for the radiator cooling fans & the variable intake manifold.

To meet styling and aerodynamic criteria, the new EF Falcon was designed to draw all of its engine cooling air from an opening positioned under the front bumper. This required the design of a new intake duct, with the opportunity also taken to develop dual electronically controlled electric fans.

The design of the new intake duct was undertaken using CAD techniques, with numerical modelling of the airflow being used to plot streamlines. In particular, the shape of the duct was tuned so that only attached (ie, laminar) airflow was present for the majority of the duct system. This design was then tested at the Ford Lara Proving Ground and in an environmental testing room. The results indicated a 32.7% improvement over the cooling system intake used in the previous model.

In addition, cooling test comparisons between a conventional engine-driven fan and electric fans showed that the latter configuration gave better cooling performance. This showed up in two ways: (1) increased headroom between the coolant temperature and its boiling point; and (2) a reduction in the airconditioning refrigerant pressure (due to more efficient condensation).

However, the new duct's 32.7% improvement in heat rejection over the previous design was reduced to only 19.8% with the electric fans fitted and operating in their "off" mode. This reduction in free-flow 80 km/h heat rejection was due to the obstruction posed by

By JULIAN EDGAR

new EF Falcon

the fans and their shroud. Even so, it still represented a significant improvement over the EA Falcon's non-ducted radiator and engine-driven fan design.

As can be seen from the photos, the Fairmont model has slightly different front-end styling to that of the Falcon. The "grille" located between the headlights is actually a fake and has no bearing on engine cooling airflow. However, the "styling bar" placed across the lower intake was found to have a potentially adverse effect on cooling air intake – if it was angled at four degrees from the horizontal, it degraded engine cooling by 8%! For this reason, production line assembly of this component must be very accurate.

Supplementing the improved intake duct is the twin electric fan package. This was also designed to give greater air flow through the radiator. One fan is a single speed unit, while the other has two speeds.

These fans are controlled by four relays linked to the EEC-V engine management computer. These relays operate the fans by means of series and parallel circuits – see Fig.1. Although seven fan-speed combinations are possible, only four are used in practice. Potential problems with NVH (noise, vibration & harshness), caused by fan beats and a whirling noise, precluded the use of all speed combinations and, in any event, proved unnecessary.

The fans may be operated by the engine management system at idle, depending on engine coolant and airconditioning refrigerant temperature. In fact, in hot environments, the airflow provided by low-speed driving and during city driving is insufficient to cool the airconditioning condenser.

The EEC-V module controls the fan speeds using the following inputs: (1) engine coolant temperature; (2) airconditioning head evaporative temperature; (3) engine speed; (4) transmission temperature; and (5) heater fan speed.

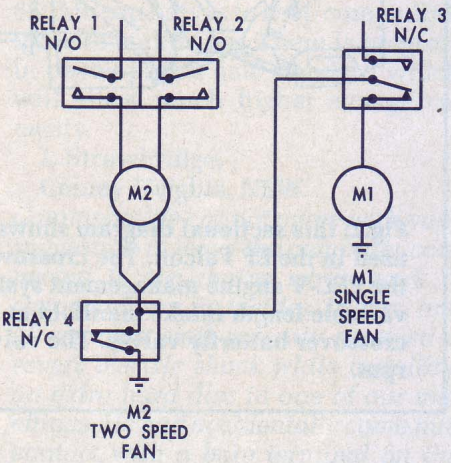
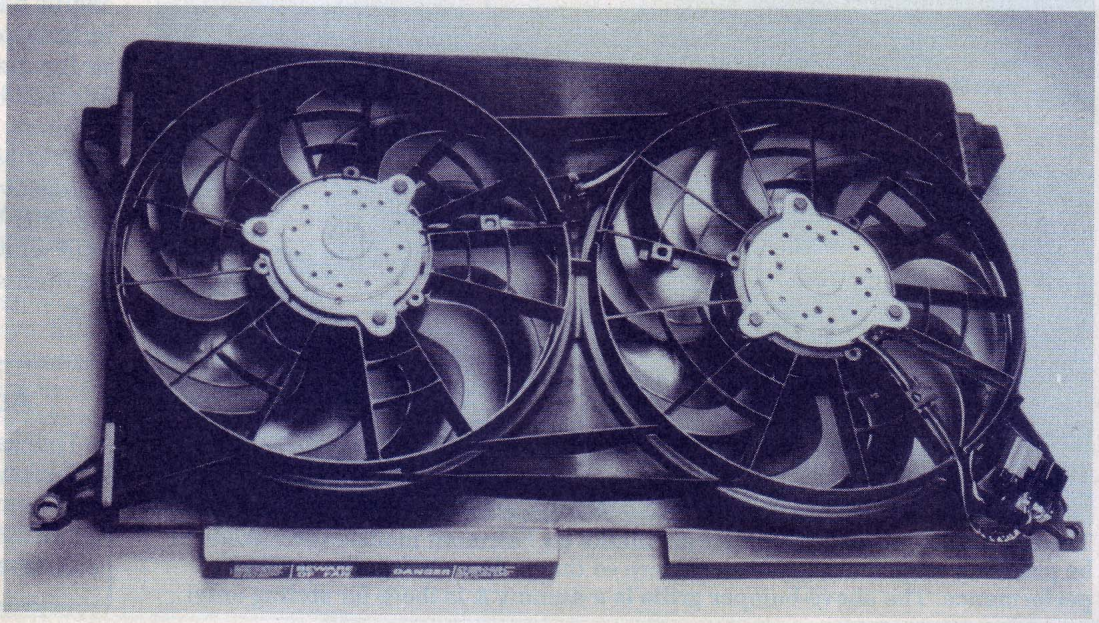
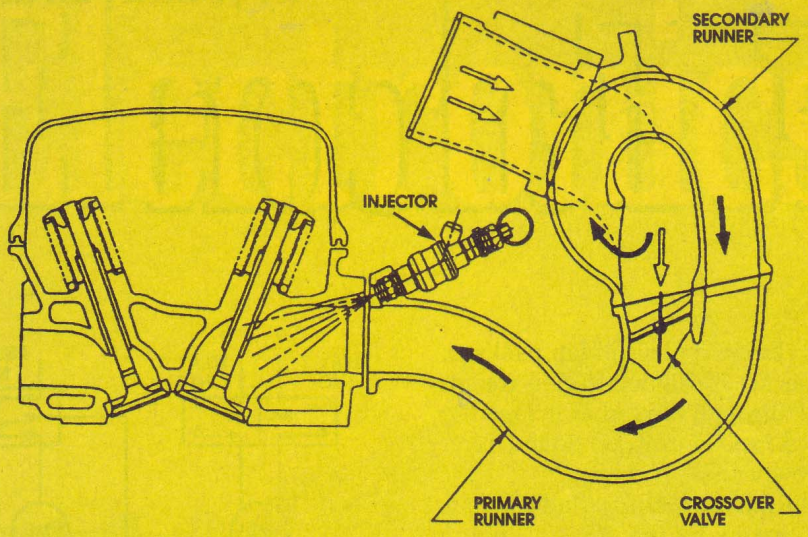


Fig.1: the dual electric fans are controlled by the EEC-V engine management system via relays. Four different fan speeds can be selected, depending on engine coolant temperature; airconditioning head evaporative temperature; engine speed; transmission temperature; & heater fan speed.

Relay operation of the fans was de-



Dual electric fans have replaced the engine-driven fan of the previous model. These are controlled by the EEC-V engine management computer on the basis of five inputs.



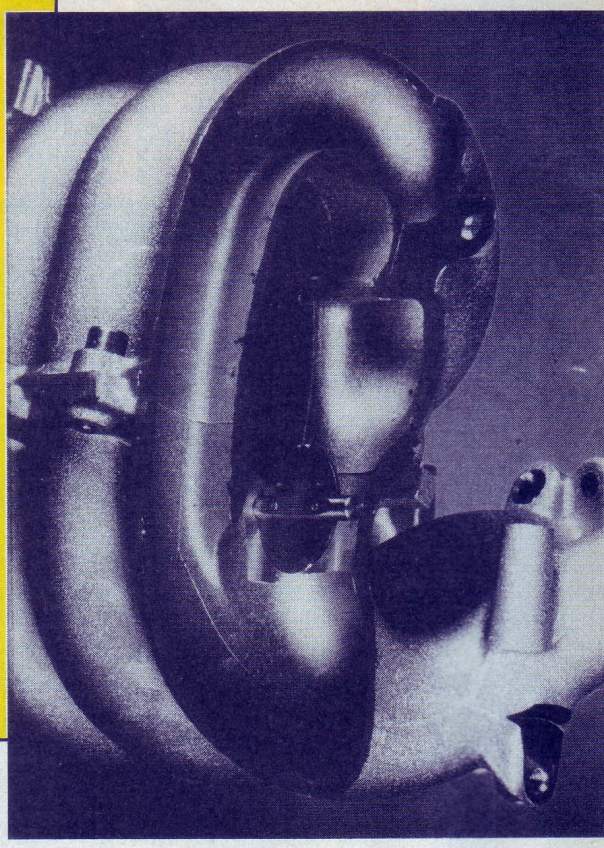


Fig.2: this sectional diagram shows the dual-resonance intake system used in the EF Falcon. The crossover butterfly valves are controlled by the EEC-V engine management system. The cutaway view of the variable length intake manifold at right clearly shows one of the crossover butterfly valves. The valve operation is dependent on engine rpm.

cided on after evaluating a pulse width modulation (PWM) system. The PWM system had the advantage of allowing stepless variable fan speed control but it was not selected because it was not sufficiently proven to meet Ford in-service durability criteria.

Intake manifold control

The new EF Falcon features a clever and compact dual intake runner system for the manifold. Depending on the movement of six internal crossover butterfly valves, the intake air is either forced to flow through a short primary runner only or to take a longer path through a secondary runner. Fig.2 shows a cross section of the intake system.

The different resonance characteristics of the dual length runners means that the volumetric efficiency of the engine is boosted at two different rpm points, rather than at a single point as for a single fixed length runner. By using dual-length runners, the resonant behaviour of the intake system can be tuned to provide maximum torque at low engine speeds and maximum power at high engine rpm, without one compromising the other.

Engine dynamometer testing by Ford indicated that a transition between short and long runners at 3800rpm gave the best results for the Falcon's engine. In particular, the new engine has worthwhile improvements in both power and torque compared to the previous single length manifold ED design.

Engine rpm is the single control criteria used to activate the manifold changeover. This is achieved by using the EEC-V module to control a solenoid which, in turn, directs an engine vacuum source to actuate the butterflies. **SC**

The bar across the under-bumper air intake on Fairmont models (left) needs to be precisely angled during manufacture so that it doesn't degrade cooling performance. The above-bumper grille is a dummy & is there for styling only!

Acknowledgement

Thanks to Ford Australia and the Society of Automotive Engineers for permission to use material from the "SAE Australasia" journal of October/November 1994.

MAILBAG

SILICON CHIP,
PO Box 139,
Collaroy, NSW 2097.

Making PC boards from photocopies

I have had good results in making PC boards from photocopies or laser prints. Here's the formulae and method for your readers:

(1) Make a reversed original full size with any method you like then photocopy it.

(2) Clean the PC board copper surface. Any method will do provided you have a shiny surface when you finish. Wipe it over with a cloth soaked in some methylated spirits. If it is physically and chemically clean, the surface will wet evenly when water is run over the surface.

(3) Make up a solution of 50% Dupont thinners and white spirit by volume. This is a solvent for toner as used on photocopies.

(4) Place the toner side of the photocopy against the copper side of a blank PC board and lightly apply the solvent to the rear of the photocopy with light pressure. Ensure that the paper is wet. With a little practice you will get the toner to come off cleanly onto the copper (now the right way around).

(5) Let it dry for a few hours to ensure all of the solvent has evaporated and to let the toner re-harden. Then etch and drill in the normal way.

Graham Dicker,
Kensington, SA.

CD-ROMs have only 660 megabytes

Just a few thoughts on Darren Yates' article on adding a CD-ROM to your computer, as featured in the February 1995 issue of SILICON CHIP.

(1) When installing any peripheral to a computer it is preferable to leave the computer plugged into a mains (240V) supply (with the power turned off). Otherwise there is no reference to ground and the mere act of innocently plugging in a card may in fact cause considerable damage to the computer, due to ESD that your body (and hand) will be wielding. Also for the above reasons, you should perform any "surgery" on a table or bench – not the carpet!

(2) A CD-ROM at present is limited to 660 megabytes. This is the same whether the drive is double-sped or not as the mere act of swapping a CD-ROM into a double speed drive does not double the capacity of the disc. It merely doubles the drive's motor speed which provides double the data transfer rate and hopefully half the access time.

The reason we are "stuck" with 660Mb capacity is to keep compatibility with audio CDs. There is progress in developing a new standard which will allow much higher storage capacity.

I. Strawbridge,
Canley Heights, NSW.

Comment: We cannot agree with your suggestion to leave the computer connected to the mains while work is carried out on its insides. In fact, one of our own staff recently received a severe electric shock while installing an extra hard disc in one of our machines. He had accidentally come into contact with a bare terminal on the mains switch – such things can happen very easily.

The reference to a double-speed CD-ROM having a 1.2Gb capacity is quite wrong – a silly mistake that was noted before going to print but by then it was too late. Philips and Sony have recently suggested a new standard for CD-video discs which will provide 3.7Gb on one layer and 7.4Gb on two. This could ultimately be quadrupled if there is a move to blue laser LEDs.

Keeping faulty parts – a form of theft?

I wish to comment on some moral and possibly legal aspects of the article "Serviceman's Log" in the February 1995 issue of SILICON CHIP.

In this article the author tells how he was unable to repair a faulty remote control and eventually sold its owner a new one. In the Serviceman's words, "the old one finished up in the scrap box as a possible source of spare bits" (p.64). This raises some interesting questions. Did the Serviceman believe that he was entitled to keep the faulty device? If so, on what grounds, since it was clearly the customer's property?

Alternatively, if the customer had given it to the Serviceman, surely this fact should be mentioned. Later in the article, the Serviceman describes how he found and fixed the fault, concluding "so I now have a spare unit, which will come in handy for testing". Did he tell the customer about this, and if not, why not?

It would seem that the practice by servicemen of keeping faulty appliances or parts of such appliances is somewhat widespread, since another article (in another magazine) refers to "a working set that was junked because of a bad tube". But if in each of these cases the owner's permission had not been given (and there is nothing in the articles to suggest that it had), then isn't this a form of theft?

B. Smith,
Glen Iris, Victoria.

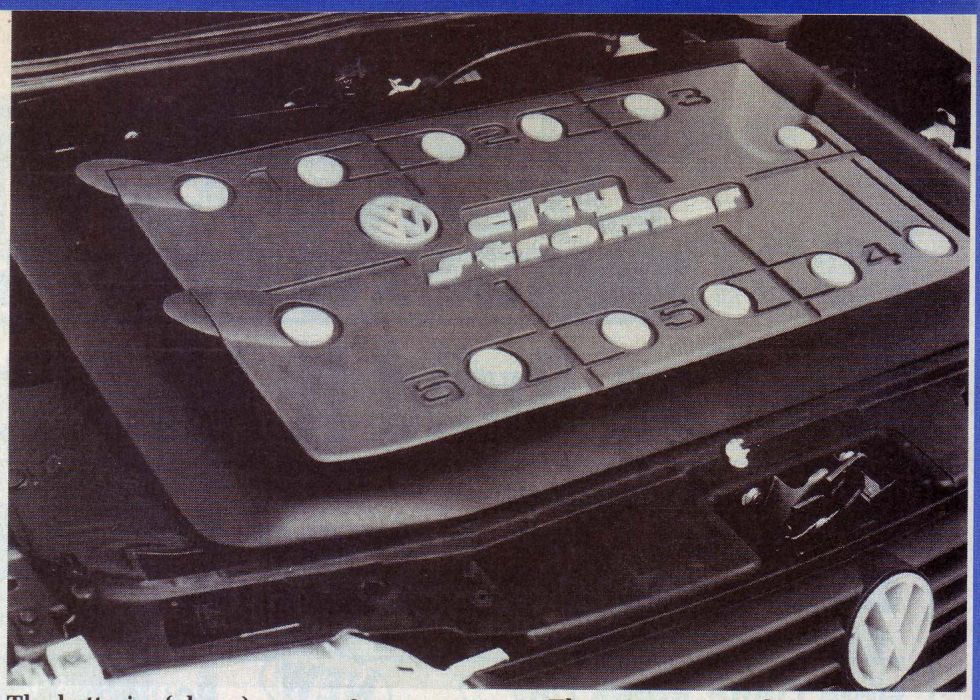
Comment: of course a serviceman needs a customer's permission to keep any faulty parts or equipment that can not be economically repaired. No serviceman would simply assume that he is entitled to "confiscate" someone else's property – if he did, that would indeed amount to theft.

In fact, our Serviceman writer has alluded to this on a number of occasions in the past, when he has described how a customer has retrieved a faulty board or whatever and prevented him from later following up on the exact cause of the fault, to satisfy his curiosity.

And as for a set with a crook tube, why would you want it back? Unless you have an identical set and intend keeping it for spares, it's nothing more than junk.

The battery powered VW Golf CityStromer uses maintenance-free lead-gel batteries for a top speed of 100km/h & a range of about 80km. Refuelling takes on a new meaning with this car – just plug it into a handy power point.

VW releases electric car



The batteries (above) carry a 3-year warranty. They power a 17.5kW synchronous electric motor & this drives through a conventional clutch & gearbox.

an

Now available in Germany, the battery-powered VW Golf is claimed to be the first production electric car to go on sale anywhere in the world. Its performance is poor relative to its petrol-powered brethren, though.

By JULIAN EDGAR

Manufacturers continue to trumpet their progress with electric vehicles; a technology largely stalled for the last 20 years because of a lack of progress in battery design. However, unlike many manufacturers, Volkswagen is actually selling its design to the public; a welcome change from numerous electric 'concept' cars which have remained unavailable to the mass market.

The VW Golf CityStromer uses maintenance-free lead-gel batteries which power a synchronous motor with an output of 17.5kW. This drives through a conventional manual gearbox and clutch. The CityStromer has a range of up to 80km, a top speed of 100km/h and can accelerate to 60km/h in 13 seconds. By comparison, the 2-litre petrol-engined Golf can accelerate to 100km/h in the same time the battery-powered unit takes to get to 60. It also has a range of at least 560km and a top speed of nearly 200km/h.

The batteries of the Stromer are split between the front and rear of the vehicle – a strategy designed to minimise the handling changes which would otherwise be associated with locating a heavy mass of batteries at one end of the car. Prototype vehicles covered around 1.4 million kilometres during testing and this provided VW with the confidence to offer a 3-year unlimited kilometre warranty on the batteries.

Volkswagen also plans to release an electro-diesel hybrid at some stage in the future. In the meantime, the electric vehicle is on sale in Germany for the equivalent of $33,000. There are no plans to sell the vehicle in Australia at this stage. **SC**

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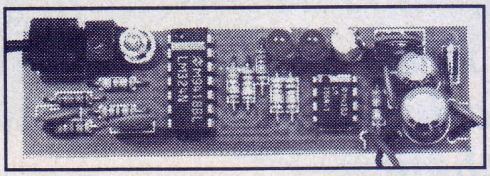

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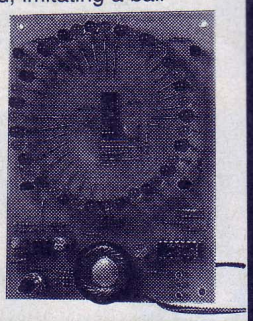

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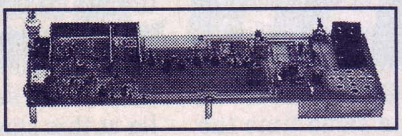

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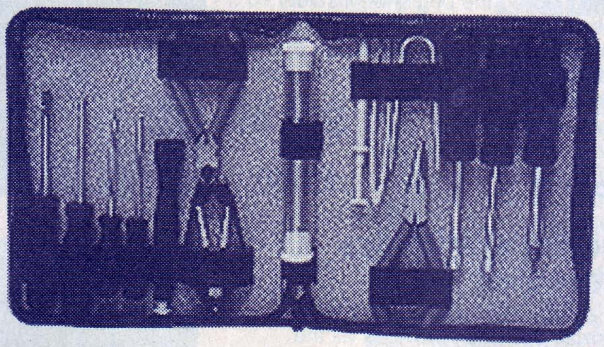

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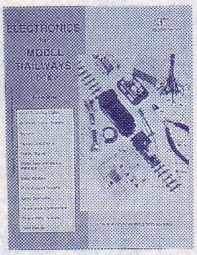

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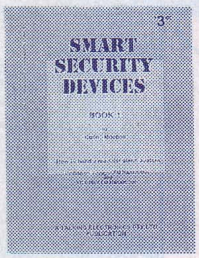

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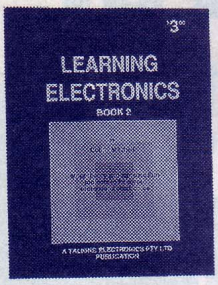

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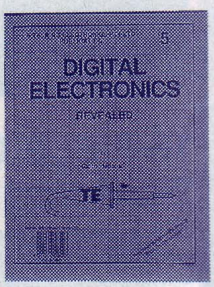

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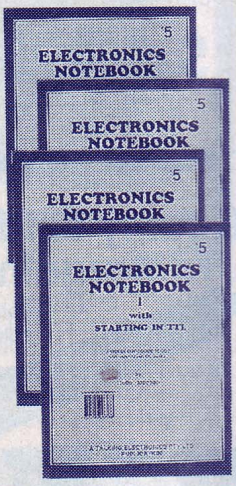

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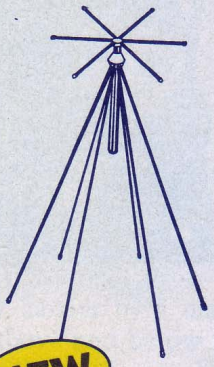

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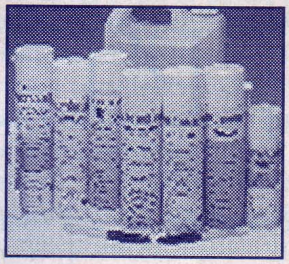

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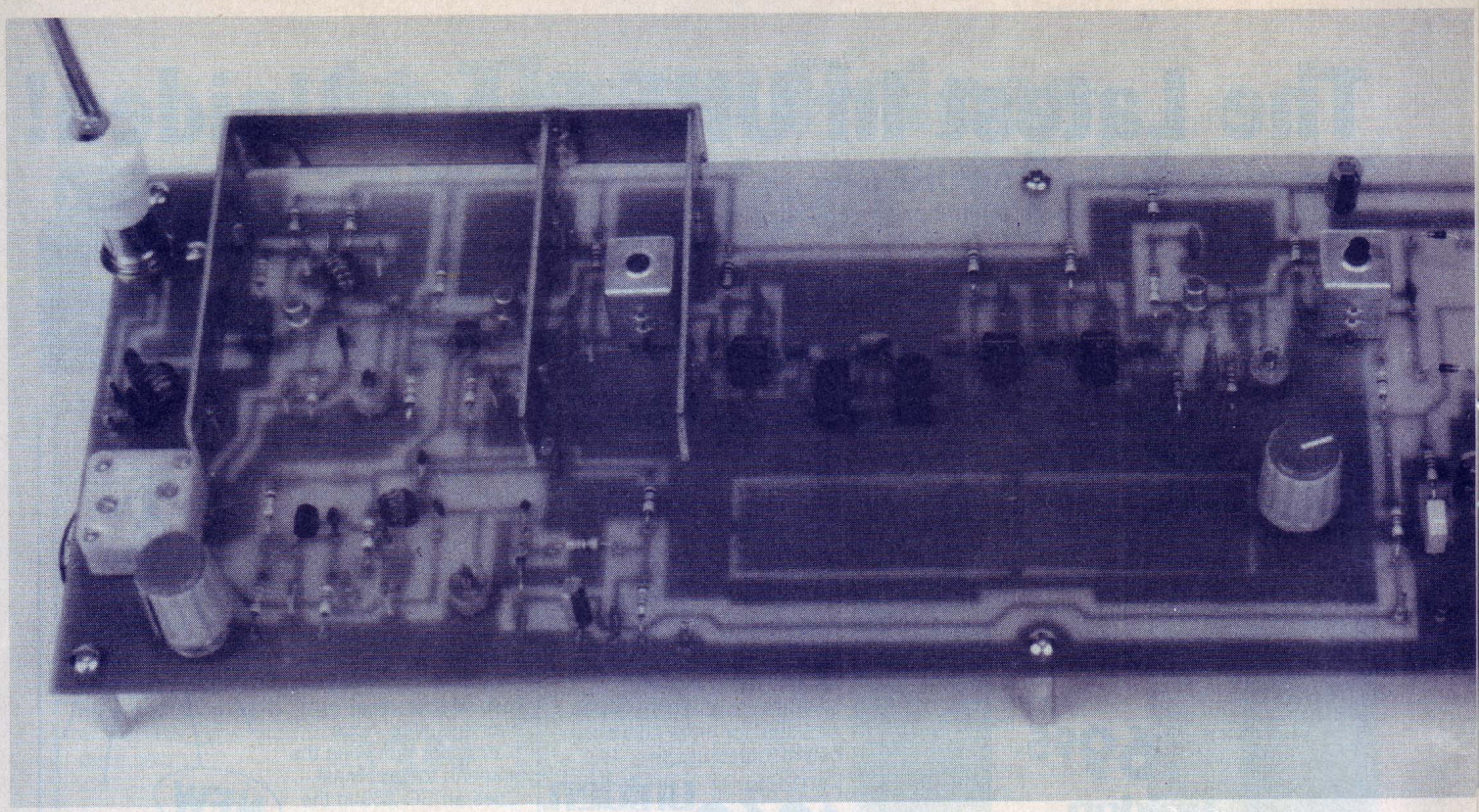

BUILD AN FM RADIO TRAINER; PT.1

This FM Radio Trainer is ideal for learning the basics of FM circuitry. By building it, you will not only gain a very good understanding of FM receiver principles but will also acquire an FM radio which has very good performance.

By JOHN CLARKE

The AM Radio Trainer described in SILICON CHIP in June 1993 was very popular with schools and TAFE colleges as a project to demonstrate receiver principles. However, since then, many popular AM stations have moved across to the FM band, so many people would now prefer to build an FM radio.

The SILICON CHIP FM Radio Trainer is designed as a learning aid for people studying electronics. Most mono FM receivers use one or two integrated circuits (ICs), with a few external components. However, for this design, we have opted for a more discrete approach, so that the major circuit blocks are all clearly separated.

To simplify construction, we have produced a PC board which has a screen printed overlay. This shows the position of each component plus its circuit interconnections. In addition, the layout on the PC board closely follows the circuit layout, so that the novice can easily come to grips with the functions of the various components.

Although some ICs have been used in the circuit, each only performs a single task. The circuit is therefore discrete in the sense that each functional block is separate and this makes it easy to understand what it does. The tuner is also easy to build and align, despite the fact that some coil winding is involved (full details will be published next month).

The alignment is carried out with the aid of a simple 10.7MHz oscillator, which we will describe next month. Apart from that, the only other items required for alignment are a multimeter and a plastic trimming tool.

Performance

The performance of the FM Radio Trainer is shown by the accompany-

Main Features

- Ideal for learning FM receiver circuitry
- Mono output
- On-board amplifier & loudspeaker
- Battery powered for safety
- Circuit & PC board overlay have same layout
- Excellent signal-to-noise performance
- Low distortion
- Receives local & strong distant stations with on-board extendable antenna
- Automatic frequency control (AFC) keeps radio on-station
- Calibrated tuning dial
- Reduction drive for ease of tuning
- Easy alignment using a simple IF oscillator & a multimeter

ing graphs and the specifications panel. As shown, the usable RF signal level is around 30µV, at which point the audio signal level is about 6dB down (half level). At 100µV, the signal-to-noise ratio is better than 70dB which is quite a good figure. The ultimate signal-to-noise ratio is 82dB and there are very few commercial tuners which would approach this figure.

So although the radio is not super sensitive, it provides excellent performance on all local stations, with good reception for signals up to 70kms away. In fact, this receiver will better many commercial receivers when it comes to performance.

What is FM anyway?

Before getting involved in how the circuit works, let's first take a look at the basic principles of FM transmission.

FM or frequency modulation is a method of applying information to a radio frequency (RF) carrier. If the RF carrier is fixed at one particular frequency and level, then the only way that information can be conveyed is by switching the RF signal on and off. This is the technique used for Morse Code.

By suitably modulating the carrier with another signal, however, we can transmit speech or music. One method is to vary the level of the carrier as shown by the bottom waveform of Fig.1. This technique is called amplitude modulation (or AM) and we can detect these changes in amplitude using a suitable AM receiver that's tuned to the carrier frequency.

Frequency modulation (or FM), on the other hand, conveys information by varying the frequency of the carrier. Fig.1 shows a typical FM waveform. Note that the amplitude of this waveform is kept constant.

At the other end, the variations in carrier frequency are detected (or demodulated) in the receiver to recover the original audio. Any variations in amplitude that may occur in the received signal are effectively ignored, which means that FM receivers are far less prone to electrical interference than their AM counterparts.

Broadcast band FM transmitters modulate the RF carrier by a maximum of 75kHz above and below the carrier frequency. They also include pre-emphasis, whereby signals above 3.183kHz (a 50µs time constant) are boosted. These signals are subsequently restored to normal in the receiver using a complementary de-emphasis circuit. The idea here is to reduce high-frequency noise in the output of the tuner.

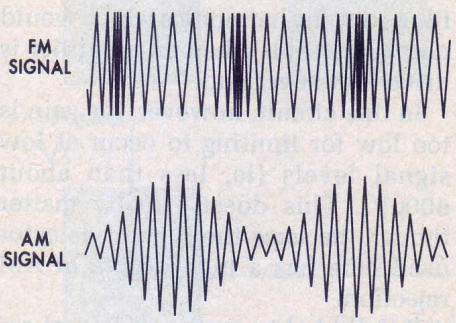

Fig.1: an FM signal (top) conveys information by varying the frequency of the carrier. In an AM signal, it is the carrier amplitude that is varied.

Block diagram

The circuit for the FM Radio Trainer is based on the superheterodyne principle. Fig.4 shows the general configuration. The antenna at left feeds into a bandpass filter, which is a parallel resonant circuit comprising inductor L1 and two capacitors. These tune the filter to the centre of the FM band (ie, to around 100MHz).

Following the bandpass filter is an RF amplifier stage. This stage has a parallel resonant circuit which is tuned by L2 and variable capacitor VC1. The latter is one section of a tuning gang capacitor and can tune the RF amplifier to any nominal frequency from 88-108MHz. The bandwidth of the tuned circuit is about 200kHz.

By this means, the wanted (or tuned) signal is amplified, while other signals are rejected.

Following the RF amplifier, the signal is fed to the mixer (Q2 & T1) where it is mixed with the local oscillator signal. VC3, the second section

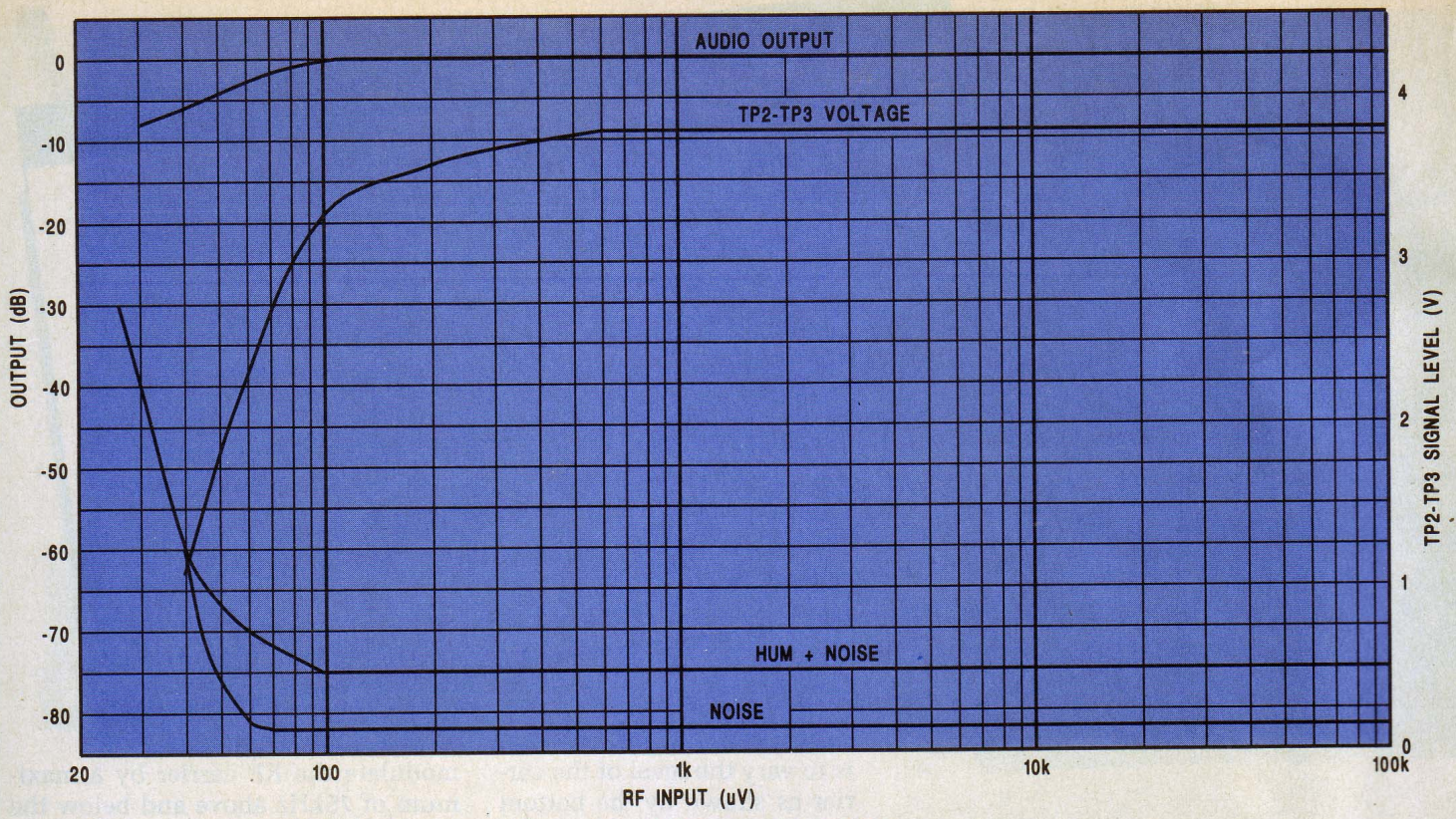

Fig.2: these curves plot the hum & noise performance of the prototype. They also show the audio output level & the filtered detector output (TP2-TP3) voltage. Full limiting does not occur until the RF input reaches about 600µV but this is not important in this circuit due to the type of detector employed.

of the tuning gang capacitor, tunes the local oscillator by resonating with inductor L3. In operation, the local oscillator runs at 10.7MHz less than the tuned RF signal (ie, it runs from 77.3-97.3MHz, depending on the setting of VC3).

It is in the mixer that the superheterodyne process takes place. The word "heterodyne" refers to a difference in frequency or beating effect, while the "super" prefix refers to the fact that the beat frequency is supersonic (ie, well beyond the range of human hearing).

Four signals are produced as a result of the mixing process: the two original signals plus the sum and difference frequencies. These are then passed to an IF (intermediate frequency) amplifier and bandpass filter stage based on IC1-IC3, XF1 and Q4. This stage is tuned to ensure that only the 10.7MHz difference frequency (now known as the IF) is allowed to pass.

In reality, the IF amplifier consists of four separate amplifier stages (IC1, IC2, IC3 & Q4) which, when losses in the bandpass filter are taken into account, have an overall gain of about 1000. This figure is low by comparison with typical FM tuners which generally have an IF gain of 10,000 or more to ensure that the IF signal is driven into limiting.

Limiting

Limiting simply refers to the fact that the signal is driven well into overload in the IF amplifier stages. This is done to eliminate any amplitude variations in the tuned signal before it is fed into the demodulator. This is one of the factors that enables FM tuners to reject atmospheric and man-made noise.

Note that no distortion is introduced by the limiting process because the final stage is tuned to 10.7MHz. This filters out any harmonics which would normally result when an amplifier is driven into overload.

In this circuit, however, the gain is too low for limiting to occur at low signal levels (ie, less than about 600µV). This doesn't really matter though, because the type of detector used here has a high degree of AM rejection.

As alluded to earlier, the local oscillator frequency always "tracks" the tuned frequency of the RF amplifier so that the difference between their output frequencies is 10.7MHz. So if the radio is tuned to 88MHz, the local oscillator will be set to 88 - 10.7 = 77.3MHz. Similarly, if the radio is tuned to the upper limit of the FM band at 108MHz, the local oscillator operates at 97.3MHz.

All this happens automatically by virtue of the 2-section tuning gang – one section controlling the RF amplifier and the other the local oscillator.

The 10.7MHz difference frequency is standard for broadcast band FM receivers. The big advantage of producing an IF signal is that we now only need to provide gain at one frequency rather than for the whole 88-108MHz range which would require complicated filters and a multi-gang capacitor to track with the local oscillator.

The output from the IF stage is now fed to a demodulator (T4, D1 & D2) to recover the audio signal. This stage also includes the necessary de-emphasis to compensate for the pre-emphasis in the treble of the transmitted signal. From there, the demodulated audio is fed to an audio amplifier (IC4) and this then drives the loudspeaker.

Automatic frequency control

There's one important feature that we haven't yet mentioned and that's the AFC line. AFC stands for auto-

matic frequency control and it works to keep the local oscillator in lock with the tuned signal, so that the radio does not drift off station. It also produces a "snap-in" effect, whereby the station suddenly locks in as the tuning approaches the station frequency.

As shown on Fig.4, the AFC line is derived from the demodulator. The resulting control voltage is then fed back to the local oscillator. We'll examine the control action in some detail when we come to the circuit description.

Circuit details

Refer now to Fig.5 for the circuit of the FM Radio Trainer. It's main components are dual-gate Mosfets Q1, Q2 & Q4, high frequency transistor Q3, three HF (high frequency) gain blocks (IC1-IC3), and audio amplifier stage IC4. The function of each stage is shown on Fig.5 and, in addition, each stage can be directly related back to the block diagram (Fig.4).

Starting at the antenna, the incoming RF signal is coupled to the junction of two capacitors (39pF & 47pF) which, together with parallel inductor L1, form the input bandpass filter. A 1kΩ resistor is included in parallel with L1 and this damps out the Q of the filter so that it covers the entire FM band without adjustment.

This input filter prevents signals with frequencies outside the FM band from entering the circuit and possibly overloading the following stages.

Following the input filter, the RF signal is fed via RF1 to Q1. This is a BFR84 dual-gate Mosfet amplifier which operates in common source configuration. Its quiescent current is set by the 330Ω source resistor and this is bypassed by a .01µF capacitor to ensure maximum AC gain. The gain is set to a high value by biasing G2 to around 6.5V, as set by the 10kΩ and 27kΩ bias resistors.

The amplified signal appears at Q1's drain and is tuned mainly by variable capacitor VC1 and inductor L2. Note that the junction of L2 and the 47Ω decoupling resistor is bypassed by a .01µF capacitor. As a result, L2 is effectively grounded at this point as far as RF signals are concerned. The same technique is used to provide an RF ground for one side of L3 in the local oscillator.

The 56pF capacitor in series with VC1 effectively reduces the tuning capacitance range from 2-160pF to 1.9-41pF. This is done to restrict the bottom end of the tuning range to the

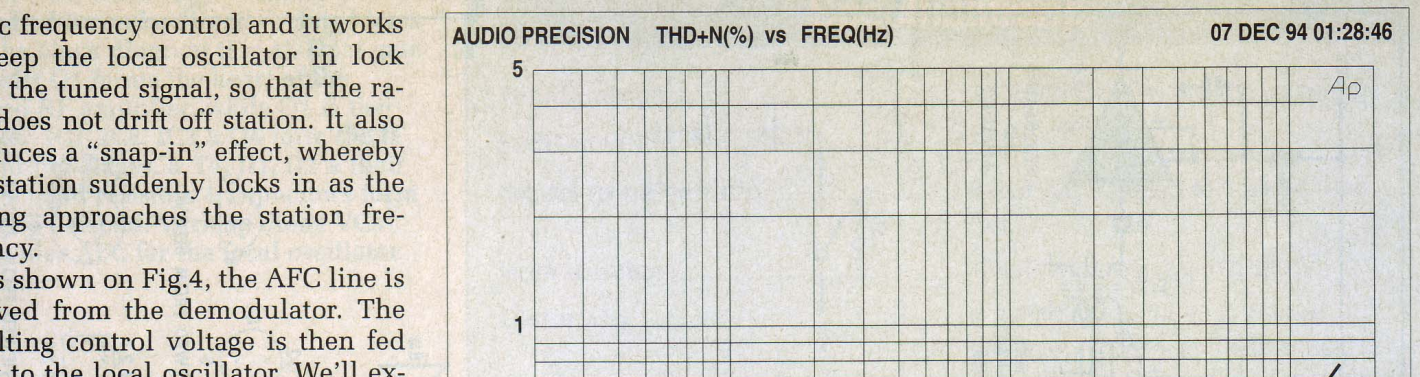

Fig.3: the tuner has excellent distortion characteristics, as revealed by these plots at 60kHz deviation & 75kHz deviation (measured at the demodulator output). Note that the THD is 0.32% at 1kHz & 75kHz deviation & less than 0.2% at 1kHz & 60kHz deviation.

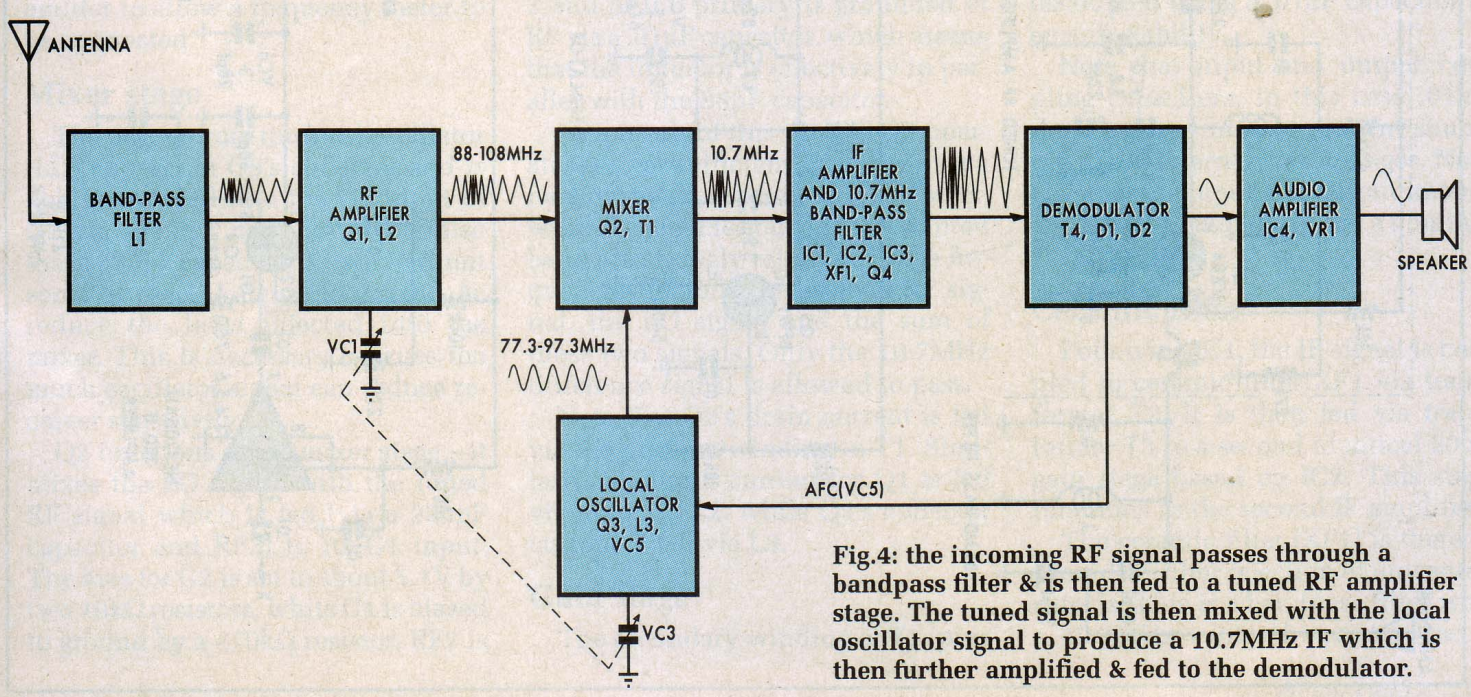

Fig.4: the incoming RF signal passes through a bandpass filter & is then fed to a tuned RF amplifier stage. The tuned signal is then mixed with the local oscillator signal to produce a 10.7MHz IF which is then further amplified & fed to the demodulator.

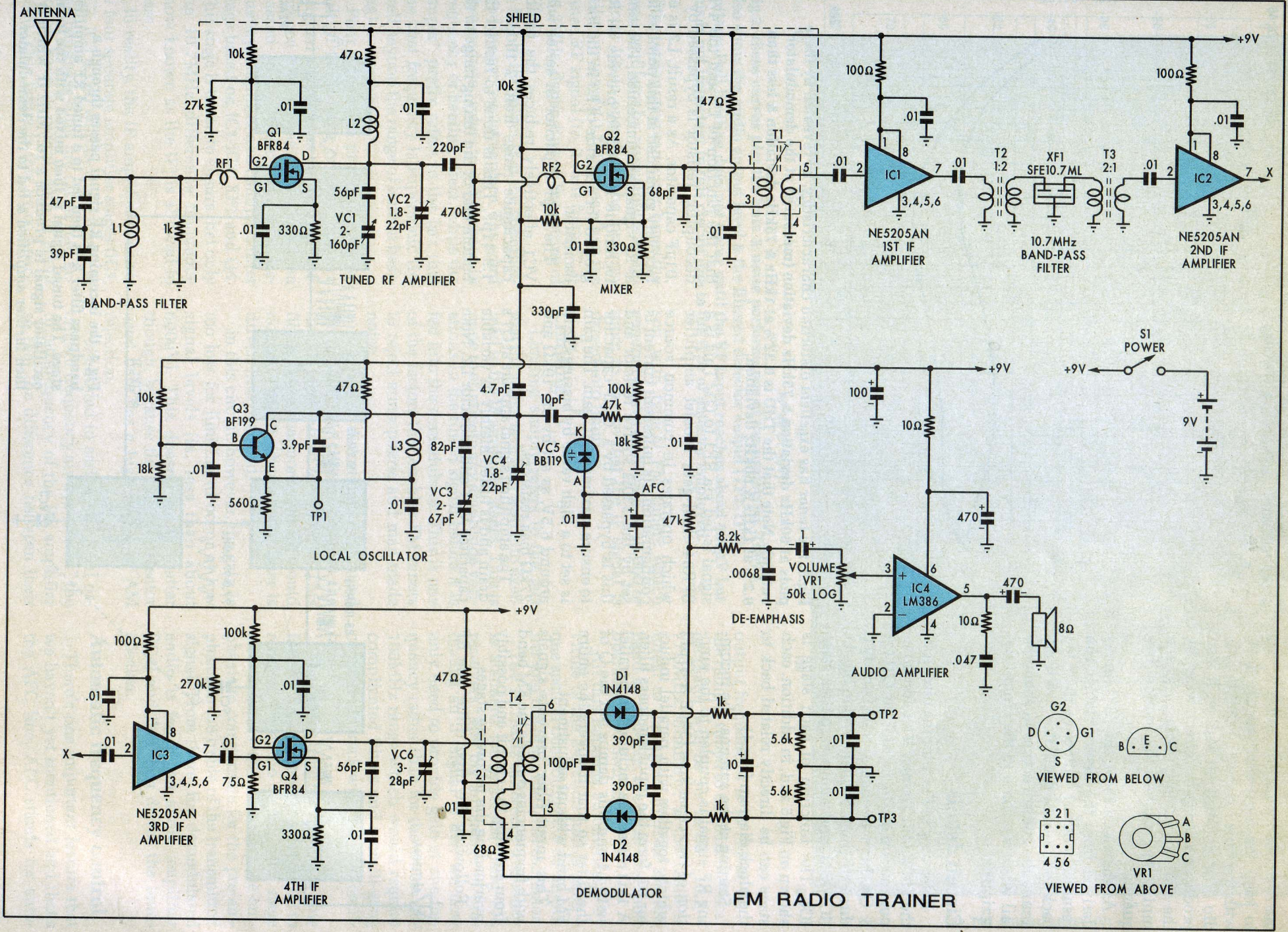
ANTENNA
SHIELD
+9V
BAND-PASS FILTER
TUNED RF AMPLIFIER
MIXER
NE5205AN 1ST IF AMPLIFIER
10.7MHz BAND-PASS FILTER
NE5205AN 2ND IF AMPLIFIER
LOCAL OSCILLATOR
S1 POWER
9V
DE-EMPHASIS
VOLUME VR1 50k LOG
AUDIO AMPLIFIER
NE5205AN 3RD IF AMPLIFIER
4TH IF AMPLIFIER
DEMODULATOR
VIEWED FROM BELOW
VIEWED FROM ABOVE
FM RADIO TRAINER

Fig.5 (left): each stage in the circuit is labelled & can be directly related back to the block diagram (Fig.4). Dual-gate Mosfet Q1 forms the heart of the tuned RF amplifier, while Q2 is the mixer. IC1, IC2, IC3 & Q4 form the IF amplifier stages, & T4, D1, D2 & their associated resistors & capacitors form a ratio detector. Varicap diode VC5 provides AFC for the local oscillator.

Specifications

Tuning range	88-108MHz (FM broadcast band)
50dB quieting sensitivity	18µV
Signal-to-noise ratio	82dB with respect to 150mV (see Fig.2)
Hum & noise	-75dB with respect to 150mV
Distortion	0.32% THD at 1kHz & 75kHz deviation; <0.2% at 1kHz & 60kHz deviation (measured at demodulator output)
Frequency response	-3dB at 3Hz & 30kHz at demodulator output; -3dB at 40Hz & 30kHz at power amplifier output
Demodulator output	150mV RMS for 75kHz deviation at 1kHz
De-emphasis	50µs
AM rejection for 30% modulation	30dB for 100µV input; 53dB for 1mV input
Current drain	110mA @ 9V & minimum volume
Minimum operating voltage	5.5VDC
Maximum operating voltage	10.5VDC

Note: although a 9V battery can be used to power the FM Radio Trainer, it will have a relatively short life. For prolonged usage, we recommend powering it from a 9V 300mA DC plugpack. Be sure to remove battery first.

broadcast band. In addition, trimmer capacitor VC2 is included in parallel with these two components and is used to set the minimum tuning capacitance. It is adjusted during alignment so that the maximum tuning frequency is 108MHz.

Local oscillator

Q3 and its associated components make up the local oscillator. This transistor is biased by the 10kΩ and 18kΩ resistors connected to its base, and by a 560Ω emitter resistor. It oscillates by virtue of its tuned collector load and the 3.9pF feedback capacitor between its emitter and collector.

The collector load is tuned using VC3, while the series 82pF capacitor effectively reduces VC3's range to 2-37pF (down from 2-67pF) to limit the bottom end of the frequency range to the required value. VC4 sets the minimum capacitance across L3 and is adjusted during alignment to set the upper frequency limit of the local oscillator.

For this reason, a test point (labelled TP1) has been provided at Q3's emitter to allow a frequency meter to be connected.

Mixer stage

The output from the local oscillator (LO) appears at Q3's collector and is lightly coupled into the G2 input of Q2 via a 4.7pF capacitor. Note also that a 330pF capacitor is used to shunt some of the LO signal to ground, to reduce the level injected into the mixer. This is necessary because too much oscillator signal can reduce receiver sensitivity.

Q2 functions as the mixer stage – it mixes the LO signal with the tuned RF signal which is fed (via a 220pF capacitor and RF2) to its G1 input. The bias for G2 is set to about 5.1V by two 10kΩ resistors, while G1 is biased to ground by a 470kΩ resistor. RF2 is included to prevent parasitic oscillation in Q2.

Q2's drain load is tuned to 10.7MHz using a 68pF capacitor and an adjustable ferrite-cored inductor (the primary winding) in IF transformer T1 (between pins 1 & 3). Note that the pin 3 end of the primary is grounded at RF via a .01µF capacitor, which means that the inductor is effectively in parallel with the 68pF capacitor.

As a result of this tuning, Q2 operates as a very efficient amplifier over a narrow band centred on 10.7MHz, while frequencies outside the wanted band are strongly rejected. These frequencies include the original RF signal, the LO signal and the sum of these two signals. Only the 10.7MHz difference signal is allowed to pass.

Note that Q2's drain current is fed via the primary winding in T1. Similarly, the drain current for Q1 is fed via inductor L2, while Q3's collector current is fed via L3.

Gain stage

The secondary winding of T1 (pins 5 & 4) now couples the IF signal from the mixer to gain stage IC1 via a .01µF capacitor. IC1 is an NE5205AN wideband high-frequency amplifier which operates with a fixed gain of 20dB (x10). Its supply rail is derived from the 9V rail via a 100Ω resistor and is decoupled using a .01µF capacitor to ensure stability.

Note that input and output coupling capacitors, in this case .01µF, must be used here to prevent shunting of the internal bias voltages. Note also that the input and output impedances of the NE5205AN are a nominal 75Ω.

Ceramic filter

Following IC1, the IF signal is coupled to ceramic filter XF1 via transformer T2. It is then fed via transformer T3 to a second identical 20dB gain stage based on IC2. This stage functions as the second IF amplifier.

The ceramic filter (XF1) is there to provide further rejection of unwanted signals. This is a bandpass filter with a 10.7MHz centre frequency and a

PARTS LIST

1 PC board, code 06303951, 363 x 115mm, with screen printed component overlay
3 pieces of blank PC board, 19mm x 70mm
2 pieces of blank PC board, 25 x 90mm
1 piece of blank PC board, 19 x 90mm
1 35mm diameter self-adhesive tuning dial
1 57mm diameter 8-ohm loudspeaker
1 9V PC-mount battery holder plus mounting screws
1 9V 216 battery
1 SPDT toggle switch (S1)
6 25mm tapped spacers plus 6-screws
2 15mm diameter knobs
1 50kΩ log pot (16mm) (VR1)
1 panel mount PAL socket
1 PAL line plug with plastic outer case
1 715mm telescopic antenna (eg, Tandy 270-1406) plus 2 x 20mm screw & nut
1 miniature dual tuning gang, 2-160pF & 2-67pF, with dial & mounting screws (VC1,VC3)
1 Murata SFE10.7ML 10.7MHz ceramic filter (XF1)
1 16mm pot shaft assembly (see text)
1 13mm round screw-on rubber foot
20 PC stakes

Semiconductors
3 NE5205AN wideband amplifiers (IC1-IC3)
1 LM386 power amplifier (IC4)
3 BFR84 dual gate VHF Mosfets (Q1,Q2,Q4)
1 BF199 NPN VHF transistor (Q3)
1 BB119 varicap diode (VC5)
2 1N4148 signal diodes (D1,D2)

Capacitors
2 470µF 16VW PC electrolytic
1 100µF 16VW PC electrolytic
1 10µF 16VW PC electrolytic
2 1µF 16VW PC electrolytic
1 .047µF MKT polyester
22 .01µF ceramic
1 .0068µF MKT polyester
2 390pF ceramic
1 330pF ceramic
1 220pF ceramic
1 100pF NP0 ceramic
1 82pF NP0 ceramic
1 68pF NP0 ceramic
2 56pF NP0 ceramic
1 47pF NP0 ceramic
1 39pF NP0 ceramic
1 10pF NP0 ceramic
1 4.7pF NP0 ceramic
1 3.9pF NP0 ceramic

Trimmer capacitors
2 1.8-22pF trimmers (VC2,VC4)
1 3-28pF trimmer (VC6)

Resistors (0.25W, 1%)

1 470kΩ	3 1kΩ
1 270kΩ	1 560Ω
2 100kΩ	3 330Ω
2 47kΩ	3 100Ω
1 27kΩ	1 75Ω
2 18kΩ	1 68Ω
4 10kΩ	4 47Ω
1 8.2kΩ	2 10Ω
2 5.6kΩ	

Coils & ferrites
2 Neosid type A adjustable inductance assemblies; 99-007-96 base, former, can & F29 screw core (T1,T4)
2 balun formers, 6 x 13 x 8mm; Philips 4313 020 4003 1 (T2,T3)
2 RFI suppression beads, Philips 4330 030 3218 2 (RF1,RF2)

Wire
1 300mm length of 0.8mm ENCW
1 1-metre length of 0.25mm ENCW
1 1-metre length of 0.125mm ENCW
1 300mm length of 0.8mm tinned copper wire
1 40mm length of 3-way rainbow cable
1 40mm length of twin loudspeaker lead

Miscellaneous
Plastic alignment tool, four rubber feet for mounting PC board, 10.7MHz alignment oscillator (to be described)

280kHz bandwidth. However, it does require nominal 300Ω source and output loads to obtain the correct amplitude and frequency characteristics.

This requirement has been provided by including T2 and T3. These two transformers provide the correct 75Ω:300Ω and 300Ω:75Ω impedance matching between IC1 and XF1 and between XF1 and IC2. If you are wondering why these transformers only have a 2:1 turns ratio, just remember that the impedance ratio is multiplied by the square of the turns ratio. So a 2:1 winding ratio produces the 4:1 impedance ratio required.

The output from IC2 appears at pin 7 and is fed to a third IF amplifier stage based on IC3. From there, the signal is coupled to G1 of dual-gate Mosfet Q4 which functions as a fourth IF amplifier stage. Its drain load is tuned to 10.7MHz by a 56pF capacitor, trimmer VC6 and the primary of T4. The 75Ω resistor on G1 provides the correct loading for IC3.

Taken together, the four IF amplifier stages and the bandpass filter provide a gain of about 1000 at 10.7MHz, with a bandwidth (or selectivity) of 280kHz. This means that signals at 10.7MHz ±280kHz are amplified and fed through to the demodulator, while higher and lower frequencies are excluded.

Demodulator

To demodulate an FM signal, the demodulator (or detector) must produce a change in audio level as the signal deviates from the 10.7MHz centre frequency. The greater the deviation, the greater the output level that must be produced. The frequency of the recovered audio depends on the rate of the deviation.

Fig.6 shows the response curve of the demodulator. This is often called an "s-curve" but the important thing is that it is linear over the -75kHz to +75kHz deviation range. As the frequency is shifted above 10.7MHz, the demodulator voltage goes increasingly positive. Conversely, as the frequency shifts below 10.7MHz, the demodulator voltage goes increasingly negative.

The demodulator is based on the windings in T4 plus diodes D1 and D2 and their associated capacitors. The secondary winding (pins 6 & 5), along with its parallel 100pF capacitor, resonates at a nominal 10.7MHz

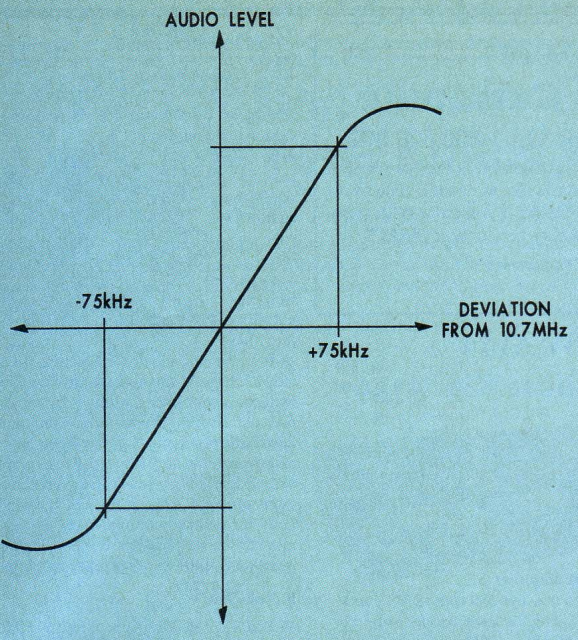

Fig.6: the response curve of the demodulator. Note that it is linear over the -75kHz to +75kHz deviation range. As the frequency is shifted above 10.7MHz, the demodulator voltage goes increasingly positive. Conversely, as the frequency shifts below 10.7MHz, the demodulator voltage goes increasingly negative.

and this is set during alignment by adjusting a ferrite slug in the coil.

In addition, there is a third winding (sometimes called a tertiary winding) which connects to the centre-tap of the secondary. The other end of this winding connects to the output of the demodulator (ie, the junction of the two 390pF capacitors) via a 68Ω resistor.

The tertiary winding is wound directly over the primary to ensure close coupling, so that the signal phases in both windings are the same. At the 10.7MHz resonance frequency, both ends of the secondary are 90° out of phase with respect to the primary and 180° out of phase with each other. In addition, the voltage across the secondary is 90° out of phase with the tertiary winding.

As a result, two equal voltages of opposite polarity are applied to D1 and D2 and so equal but opposite voltages are applied across the two 390pF capacitors. Since the voltages across the two 390pF capacitors are equal, their centre-point voltage is zero (and there is no output).

Any frequency deviations from 10.7MHz, however, produce a corresponding phase shift in the secondary. The centre-tapped secondary winding then becomes unbalanced, so that the voltage at one end (with respect to the centre tap) is greater than the voltage at the other.

Hence, when the FM signal is above 10.7MHz, the output from D1 is greater than the output from D2. Thus, the junction of the two 390pF capacitors goes positive. Conversely, when the FM signal is below 10.7MHz, the output from D2 is greater than the output from D1 and the junction of the 390pF capacitors goes negative.

Hence, as the FM signal deviates above and below 10.7MHz, the result is an audio signal at the junction of the 390pF capacitors.

AM rejection

In order to make the FM detector less sensitive to changes in the IF level, the total voltage across the two 390pF capacitors is stabilised so that it cannot vary at an audible rate. This is achieved using a filter network consisting of two 1kΩ resistors and a 10µF capacitor.

The effect of the 10µF capacitor is to keep the sum of the voltages across the two 390pF capacitors constant. This means that variations in the level of the FM signal will not produce variations in the output of the demodulator.

The two 5.6kΩ resistors and their parallel .01µF capacitors provide convenient test points which are used during the alignment procedure.

This type of FM demodulator is called a ratio detector. It differs from other FM detectors such as the Foster-Seeley detector because, as we have just seen, it incorporates AM rejection. This is important in the circuit because, as discussed earlier, limiting does not occur on low-level signals.

De-emphasis

The output from the demodulator is de-emphasised using an 8.2kΩ resistor and a .0068µF capacitor, and then fed to audio amplifier stage IC4. IC4 operates with a gain of 20; its output appears at pin 5 and drives an 8-ohm loudspeaker via a 470µF capacitor. VR1 functions as the volume control, while a Zobel network consisting of a 10Ω resistor and a series .047µF capacitor is connected across the output to ensure stability.

Power for the audio amplifier is derived from the 9V rail via a 10Ω resistor and a 470µF decoupling capacitor. This arrangement ensures a low impedance supply for IC4 over the life of the battery.

Automatic frequency control

As well as being fed to IC4, the demodulated signal is also filtered using a 47kΩ resistor and a 1µF capacitor and applied to the anode of varicap diode VC5. At the other end, VC5's cathode is connected via a 47kΩ isolating resistor to a 1.37V bias voltage, as set by a voltage divider consisting of 100kΩ and 18kΩ resistors.

Because it is a varicap diode, VC5 varies its capacitance according to the voltage across it. Its anode is at RF ground due to the .01µF capacitor, which means that VC5 and its series 10pF capacitor are effectively in parallel with the tuned circuit incorporating L3.

We can now see how VC5 provides automatic frequency control. When the radio is correctly tuned, the filtered output from the demodulator (ie, the AFC control line) is at 0V DC. However, if the local oscillator drifts off frequency, or if the tuning is slightly off frequency, then the AFC control line will apply a DC bias to VC5's anode.

As a result, VC5 changes its capacitance and this shifts the local oscillator back to its correct frequency. The 1µF capacitor across the AFC line provides a long time constant so that the low frequency audio response is maintained down to below 20Hz.

That describes the circuit description. Next month, we will continue with the full details on construction and alignment. **SC**

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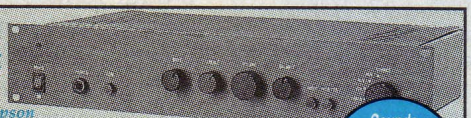
50W Stereo Amplifier Kit



(SC March/April '95)

Congratulations to Leo Simpson and the team at Silicon Chip Magazine for producing this outstanding stereo amplifier kit!

Sounds so good, your friends wont believe you built it yourself!!

Sensational, natural un-coloured high definition audio is the best way to describe this amplifier. The sound quality and overall specifications of this amplifier will compliment any sound system.

Features: • CD, tuner, VCR, AUX 1, AUX 2, Tape loop inputs • Headphone amplifier • Attractive, professionally, printed and punched front panel • 2U (88mm), 19" Chassis supplied with a durable, industrial grade powder coat finish • Includes toroidal power transformer for minimal hum, heat and greater efficiency • Very simple to build and construct • Chassis can be rack or desk mounted

K 5135 **$349.00**

Uses the Virtually Indestructible LM3886 Power IC

The power amplifier circuit of each of these kits comprises of a single National Semiconductor LM3886 chip. This brilliant new IC incorporates an amazing diversity of on board device protection against over voltage, over current, thermal runaway, short circuit load etc.

50W Stereo Amp Module Kit

$79.00

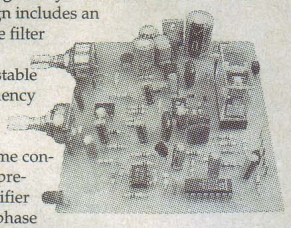
(See SC Feb '95) This is a complete stereo output module, including heatsinks, power supply components (less transformer), making it an extremely compact amplifier. Designed around the National LM3886 flat-pack IC. **K 5130**

350W Amp Module Kit

K 5180 **$189.00**

This fantastic amplifier will deliver a massive 350 watts RMS into 4 ohms. Using the latest mosfet technology and circuit design techniques this kit is supplied as a basic module, which makes it ideal to be built into subwoofer enclosures, juke boxes and mixers etc. Housed in a suitable enclosure this kit will make a simple superb mono or stereo (using 2 modules) high power amplifier for discos, public address or even in the home if you are game enough to really rattle the floor boards!

Sub-Woofer Controller Kit



(Designed by Altronics) This fantastic design includes an active filter for adjustable frequency cut off, volume control, pre-amplifier and phase shifter allowing the driving of amplifiers in either bridge or single configuration. It also features compressor limiting which means no harsh clipping if over-driven and an automatic power up / power down in response to the audio input. For maximum compatibility it's inputs can be driven from either speaker or line level. The pcb can be housed remotely within the sub-woofer cabinet with its amplifier or at the main equipment rack with the sub-woofer amplifier.

K 5562 **$49.00**

M 9120 12V AC Plugpack to Suit **$12.95**

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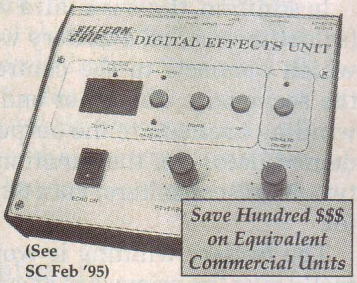
Guitar Effects Kit



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(See SC Feb '95)

This digital effects unit can produce a wide range of sound effects to enhance a musical instrument. It can be driven from a guitar or line source (or from both) and uses the latest in digital delay technology.

Features: • Echo, delay, reverberation and vibrato effects • Microprocessor controlled delay period and vibrato rate with a 2 digit display • Digital delay processing • Delay adjustable from 1-64 ms in 1ms steps • Vibrato rate adjustable from 1-10Hz in 0.5Hz and from 1-20Hz in 1Hz steps • User presets to select settings on power up • Input attenuator to prevent signal overload • Click free switching between effects in and effects out • No change in signal level between effects in and effects out

K 5538 **$189.00**

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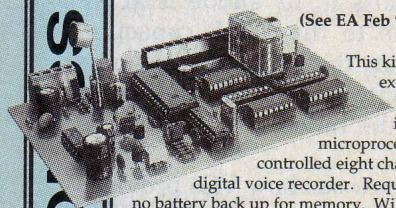
Digital Announcement Recorder Kit

NEW



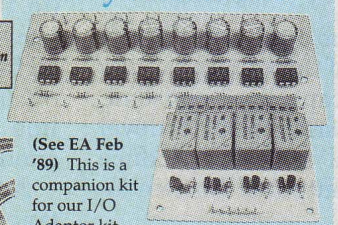
(See EA Feb '95)

This kit is an extremely flexible microprocessor controlled eight channel digital voice recorder. Requires no battery back up for memory. Will record up to 8 different messages, with a total time up to 16 seconds. Each message can be individually triggered. Features chime function, an on-board 2 watt amplifier, negative or positive trigger, once only or recycling announcement function etc.

1000's Uses Include Car Warning Alert, Alarm Systems, Door Bell etc.

K 9580 **$109.00**

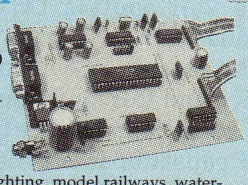
Input Buffer & Relay Driver Kit



(See EA Feb '89) This is a companion kit for our I/O Adaptor kit (K 2850). It has four relay outputs and eight opto-isolated inputs. This kit contains all parts necessary to construct both the input and output stages and even gives basic information on 240 volt triac controlling. As there is no professional software available for these items, a Qbasic program listing is supplied to help you complete your project.

K 2852 **$34.95**

I/O Adaptor Kit for PC's



(See EA July '91) Using this module you can computer control all kinds of things such as security systems, stage lighting, model railways, watering systems etc. The unit simply connects to a standard RS232C serial port on any PC. It has a 8 digital inputs controlling 8 outputs. A simple addressing systems allows multiple units to be "daisy chained" from a single RS232C port, expanding the number of inputs and outputs up to 64.

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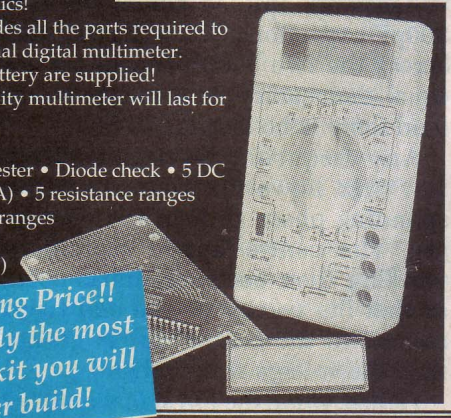
K 2400 Only $29.95



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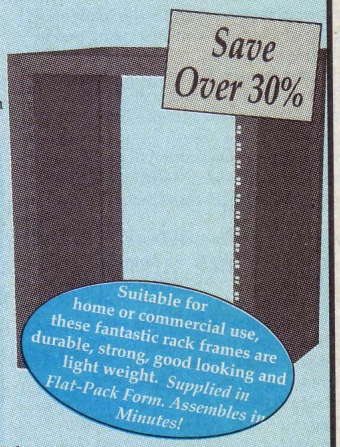
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H 5307	Side & Top Panels for H 5306			$55.00	$38
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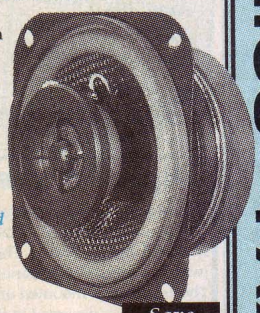
Coupled with a Centrally Mounted Tweeter, the Overall Sound Quality is Excellent!!



Specifications:
Power: 25W
Impedance:.....8 Ohms
Freq Resp:.....90Hz-20kHz
Sensitivity:.....95dB 1W/.5m

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Q 0528 Normally $21.20

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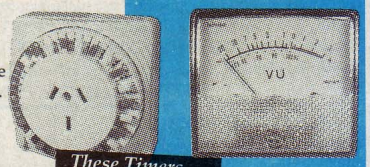

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The main controller circuitry is housed in a sturdy steel cabinet. Provision is made to house an optional back up battery if required. The keypad control unit is generally located at the front door for easy access to arming and disarming of the system. The entire system in controlled and programmed via this keypad.

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Doc JH131

If you're looking for an accurate way to control film developing times, then take a look at this Photographic Timer. It will switch on mains-powered fluorescent ultraviolet tubes or incandescent lamps rated at up to 1200W for a preset time ranging from 1-450 seconds.

A photographic timer for darkrooms

By JOHN CLARKE

Developing photos or making PC boards and front panels requires a controlled light source. Depending on the process, this could be based on special incandescent globes or ultraviolet tubes. In either case, the developing time needs to be accurately set so that the exposure is correct.

Now this is all well and good if you have a light box or enlarger which incorporates a timer but these are usually very expensive. What's more, controlling the mains power requires specialised circuitry, so we've come up with this low-cost Photographic Timer which should fit the bill.

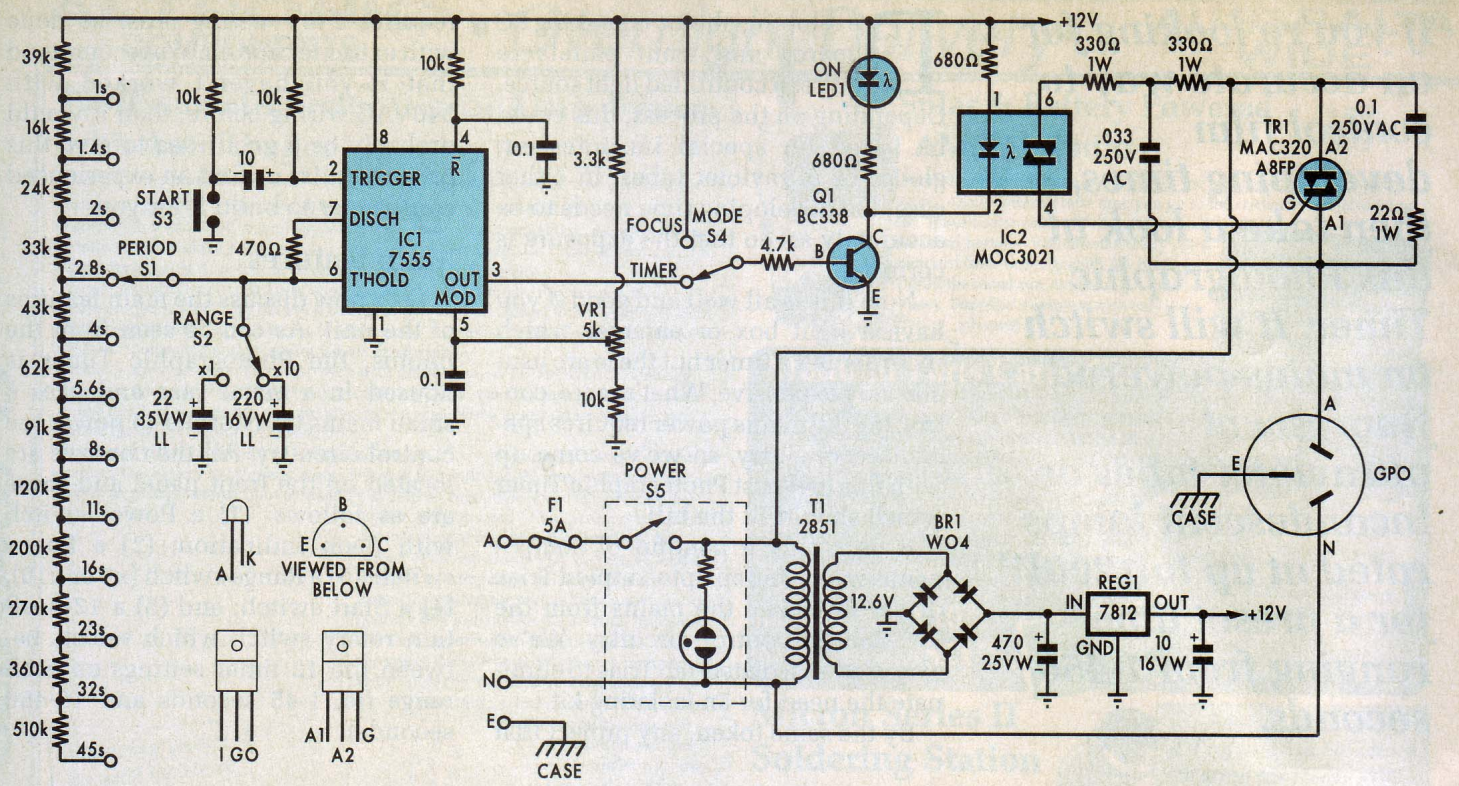
It uses only a handful of components, including an optocoupled Triac driver to isolate the mains from the low-voltage control circuitry. We've also used an isolated-tab Triac to eliminate the need for an isolating kit.

By the same token, any project that requires 240V wiring must be done with extreme caution. We recommend that if you haven't worked with 240VAC wiring before, then it would probably be a good idea to give this project a miss or find an experienced constructor to build it for you.

Main features

Let's now discuss the main features of the unit. As can be seen from the photos, the Photographic Timer is housed in a metal case and uses a small mains transformer to power the control circuitry. All the controls are located on the front panel and these are as follows: (1) a Power switch with neon indication; (2) a Focus switch; (3) a Range switch (x1 or x10); (4) a Start switch; and (5) a 12-position rotary switch which selects between the 12 timer settings on each range (ie, 1-45 seconds and 10-450 seconds).

The prototype was built into a compact metal case which is earthed. It provides timed periods ranging from 1-450 seconds over two ranges.



PHOTOGRAPHIC TIMER

Fig.1: the circuit uses 7555 timer IC1 to provide the timing period. When the start switch (S3) is pressed, its pin 3 output goes high & turns on Q1. Q1 then drives optocoupler IC2 which in turn switches on Triac TR1.

The Focus switch is typically used to switch a photographic enlarger lamp on so that an image can be focused prior to printing. The lamp is then switched off and the Start button pressed to initiate the exposure period. A red LED adjacent to the Start switch lights while ever power is applied to the 240V GPO socket mounted on the rear panel.

The 12 timing values are arranged in a geometric progression, with the square root of 2 (ie, 1.414) as the multiplier. This gives nominal values of 1, 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 23, 32 and 45 seconds on the x1 range. This type of geometric progression is ideal for photographic work, since doubling the exposure time represents one stop.

What this means is that the selector switch effectively steps in half-stop increments. This order of resolution should be quite sufficient for photographic purposes and other general exposure work involving light boxes.

Circuit details

Let's now take a look at the circuit details – see Fig.1.

The circuit is based on a CMOS 7555 timer (IC1) which is connected in monostable mode. Switch S1 selects one of 12 outputs provided by a resistive divider network to set the basic timing interval, while S2 selects between two timing capacitors to provide the x1 or x10 range. The resulting RC time constant is connected to pin 6 (threshold) of IC1 and thus sets the overall timing interval.

Note that the two main timing capacitors selected by the Range switch (S2) are both specified as low leakage (LL) types. This is necessary because at high settings of S1, the charging current is very low. As a result, standard electrolytic capacitors with their higher leakage currents would never charge up to a level sufficient to end the timing cycle (ie, the lamps would never switch off).

The circuit works like this: at power on, the reset pin (pin 4) of IC1 is momentarily pulled low via a 0.1µF capacitor. This prevents the pin 3 output of IC1 from initially going high. After a short period, the reset input is then pulled high via a 10kΩ pullup resistor and the timer can function normally.

The timing sequence is initiated by pressing the Start switch (S3). This momentarily pulls the pin 2 trigger input of IC1 low via a 10µF capacitor and this, in turn, causes the pin 3 output to go high. The 10µF trigger capacitor then quickly charges via an associated 10kΩ resistor to end the trigger pulse. This ensures that the timing period cannot be influenced by holding S3 switch down.

When S3 is released, the 10µF timing capacitor discharges via a second 10kΩ resistor connected between the switch and the positive supply rail (Vcc). The circuit is then ready for the next trigger input.

Once triggering has occurred, the pin 3 output stays high while the timing capacitor charges via the resistive

Main Features

- Controls loads up to 1200W
- Timer operates from 1-45s in 12 steps for x1 range; & from 10s-450s (7.5min) in 12 steps for x 10 range
- Timing steps arranged in 1.41:1 increments (equivalent to half a stop)
- Focus switch
- Red "safe light" indicators
- Compact case
- Isolated control circuitry & isolated tab Triac

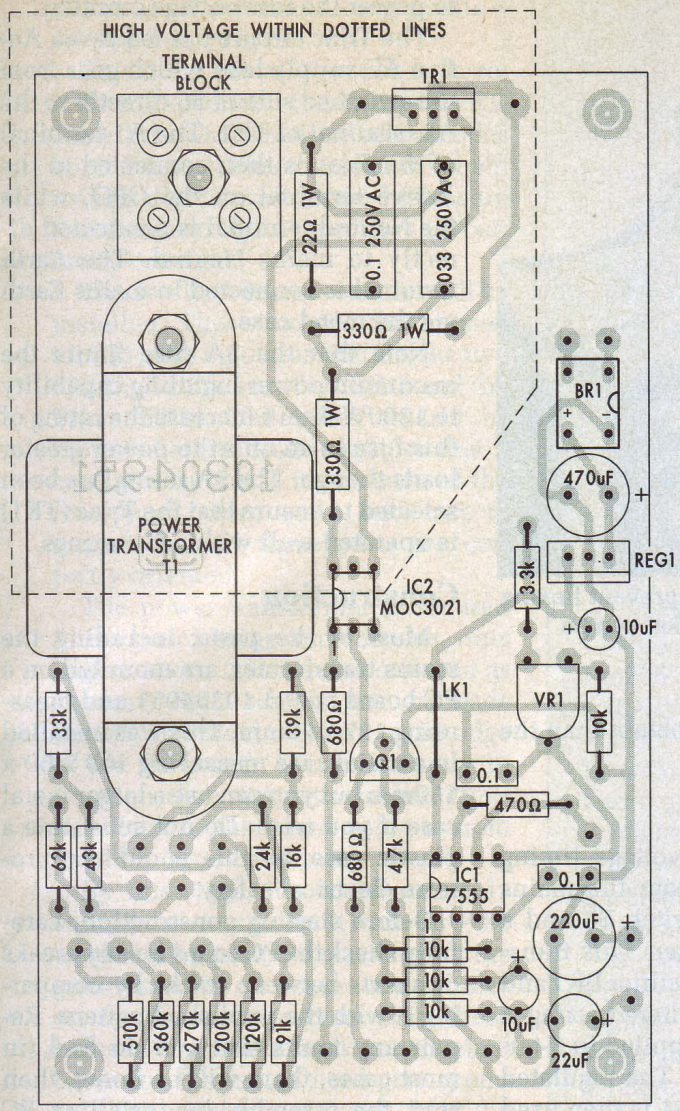


Fig.2: install the parts on the PC board as shown here & note that the parts enclosed by the dotted lines operate at mains potential when power is applied.

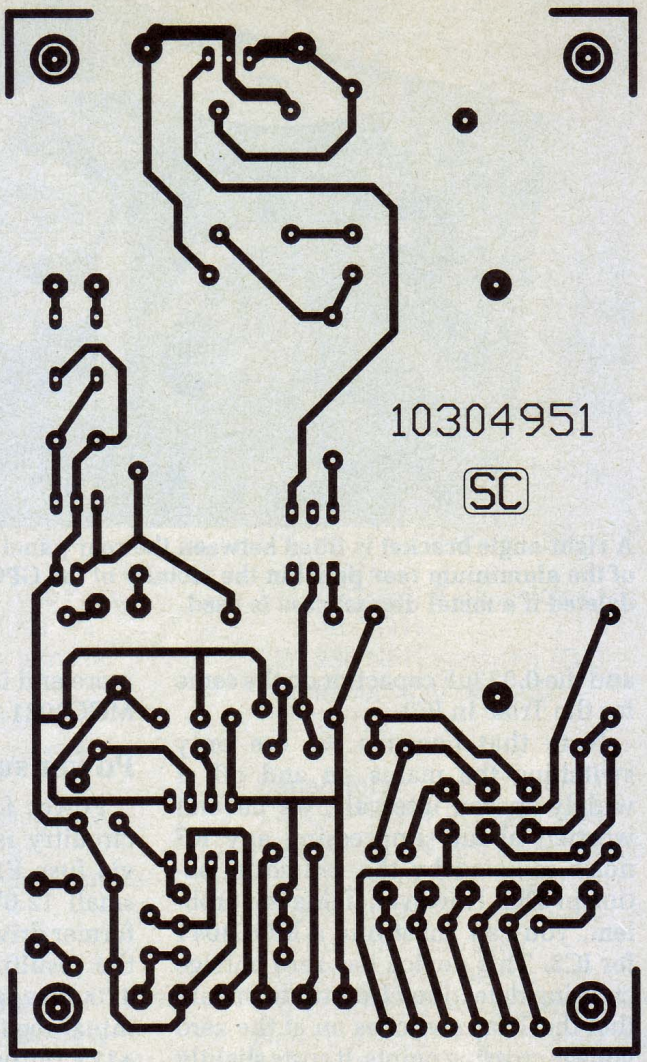


Fig.3: this is the full-size etching pattern for the PC board. It is a good idea to check carefully for etching defects before mounting any of the parts.

network selected by S1. When the capacitor voltage subsequently reaches a preset threshold, pin 3 goes low again and the timing period ends. The timing capacitor on pin 6 then discharges via the 470Ω resistor connected to pin 7. This resistor limits the capacitor discharge current to prevent damage to the IC.

The pin 6 threshold voltage is nominally 2/3Vcc but, in this circuit, can be shifted about this value by adjusting the voltage applied to the modulation input at pin 5. This is achieved using VR1 which forms part of a resistive divider connected across the supply rails. Basically, VR1 functions as a calibration control and is necessary because the timing capacitors have a very wide tolerance range (±20%).

In practice, it's simply a matter of calibrating the unit on the x1 range for one setting. The x10 range should then be within 5%, provided that the 22µF and 220µF capacitors are supplied matched – see parts list.

Power control

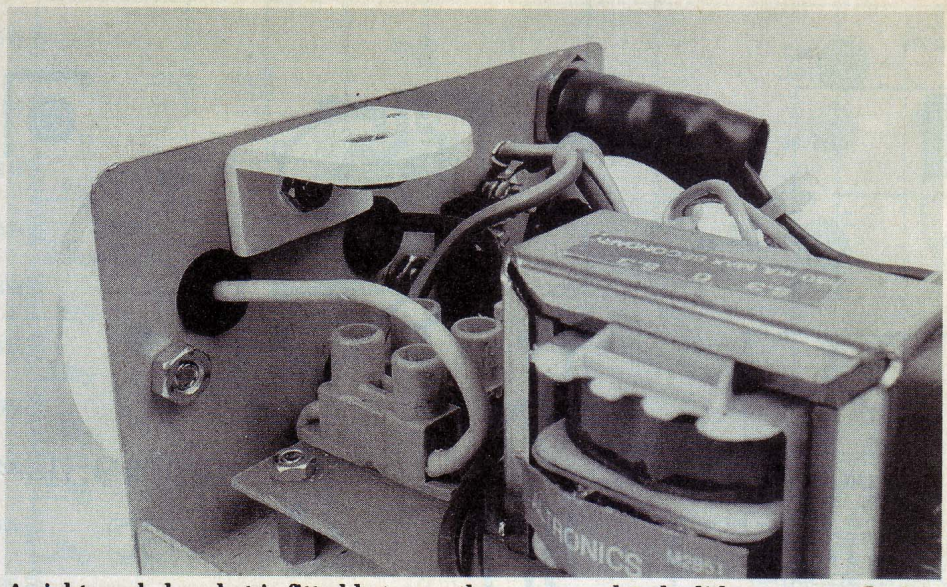
Assuming S4 selects the TIMER position, IC1's pin 3 output drives transistor Q1 via a 4.7kΩ base current limiting resistor. Q1 thus turns on whenever pin 3 is high (ie, for the duration of the monostable period). Alternatively, when S4 selects the FOCUS position, Q1's base is pulled to the positive supply rail and so the transistor is permanently held on.

Q1 in turn drives IC2 which is a MOC3021 optocoupled Triac driver. Its job is to provide very high voltage isolation between the low voltage control circuitry and the switched mains voltage. When Q1 turns on, an internal LED between pins 1 and 2 of IC2 also turns on and this triggers an internal Triac between pins 6 and 4. Finally, IC2 triggers TR1, an MAC-320A8FP isolated tab Triac, which turns on and connects the Active mains line to the Active pin on the GPO.

The 22Ω 1W resistor and the 0.1µF capacitor provide a snubber network for TR1, while the two 330Ω resistors

Warning!

Potentially lethal mains voltages are present on some components on the PC board when power is applied to this unit (see Fig.2). Do not attempt to build this unit unless you are experienced at working with mains voltages. Also, do not attempt to work on any high voltage circuitry while the unit is plugged into the mains.



A right-angle bracket is fitted between the rear panel & the lid to prevent flexing of the aluminium rear panel in the vicinity of the GPO. This bracket can be deleted if a metal diecast case is used.

and the 0.033µF capacitor do the same for the Triac in IC2.

Note that because we are only switching the mains on and off at widely spaced intervals, we haven't worried about suppressing any RF noise radiated by the switching action of TR1. However, if this is a problem, you can substitute a MOC3041 for IC2. This device has zero voltage crossing detection circuitry to ensure that the Triac switches on at the zero voltage crossing points. It costs slightly more and is harder to obtain than the MOC3021 though.

Power supply

Power for the low-voltage timing circuitry is derived from the mains via fuse F1, power switch S5 and a small 12.6V transformer. This transformer drives bridge rectifier BR1 and the resulting DC is filtered using a 470µF capacitor and applied to 3-terminal regulator REG1. The regulated +12V output from REG1 is then used to power the low voltage circuitry.

The Triac circuitry is fed by an Active AC supply lead which goes from the switched side of S5 directly to the A2 terminal of TR1. The A1 terminal of the Triac is then connected to the Active terminal on the GPO, while the Neutral terminal is connected directly to mains Neutral. The Earth terminal is connected to mains Earth via the metal case.

Note that the 5A fuse limits the maximum power handling capability to 1200W. Don't increase the rating of this fuse in an effort to power greater loads though. The 5A rating has been selected to ensure that the Triac (TR1) is operated well within its ratings.

Construction

Most of the parts, including the mains transformer, are mounted on a PC board coded 10304951 and measuring 127 x 76mm. This was installed in a metal case measuring 100 x 60 x 150mm but you can use a larger metal case if you wish. Do not substitute a plastic case, as this could compromise electrical safety.

Before starting construction, carefully check the PC board for any breaks or shorts between tracks by comparing it with the published pattern. Repair any faults that you do find (in most cases, there will be none), then start the assembly by installing PC

TABLE 1: RESISTOR COLOUR CODES

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	510kΩ	green brown yellow brown	green brown black orange brown
❑	1	360kΩ	orange blue yellow brown	orange blue black orange brown
❑	1	270kΩ	red violet yellow brown	red violet black orange brown
❑	1	200kΩ	red black yellow brown	red black black orange brown
❑	1	120kΩ	brown red yellow brown	brown red black orange brown
❑	1	91kΩ	white brown orange brown	white brown black red brown
❑	1	62kΩ	blue red orange brown	blue red black red brown
❑	1	43kΩ	yellow orange orange brown	yellow orange black red brown
❑	1	39kΩ	orange white orange brown	orange white black red brown
❑	1	33kΩ	orange orange orange brown	orange orange black red brown
❑	1	24kΩ	red yellow orange brown	red yellow black red brown
❑	1	16kΩ	brown blue orange brown	brown blue black red brown
❑	4	10kΩ	brown black orange brown	brown black black red brown
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	2	680Ω	blue grey brown brown	blue grey black black brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	2	330Ω	orange orange brown brown	orange orange black black brown
❑	1	22Ω	red red black brown	red red black gold brown

stakes at all external wiring points – see Fig.2 and Fig.3.

This done, install the wire link, resistors, capacitors and trimpot VR1. Table 1 shows the resistor colour codes but it is a good idea to also check them using a digital multimeter. Make sure that the electrolytic capacitors are correctly oriented.

The semiconductors can now all be installed. These include the transistor (Q1), the regulator (REG1), the two ICs, the bridge rectifier (BR1) and the Triac (TR1). The latter should be mounted at full lead length, so that it can later be bolted to the back of the rear panel. Once again, take care to ensure that all these parts are correctly oriented.

The power transformer is secured to the board using 3mm screws, nuts and washers. It should be oriented as shown in Fig.3, with its primary leads (brown and blue) adjacent to the edge of the PC board. Secure it firmly in position, then secure the mains terminal block to the board using a 3mm machine screw and nut.

By this stage, the board assembly should be complete. It can now be used as a template for marking out the positions of its corner mounting holes on the base of the case. Drill these holes to 3mm, then mark out and drill holes for the mains cord grip grommet, the panel mount fuse holder, the GPO socket, the earth lug and the Triac (TR1). Fig.4 shows how these parts are arranged on the rear panel.

The position of the Triac mounting hole can be determined by temporarily positioning the board in the case on 9mm spacers. At the same time, be sure to position the hole for the cord grip grommet so that it will clear the PC board. Drill a small pilot hole initially, then carefully ream and file the hole to the correct shape so that the grommet is a snug fit. This is necessary to ensure that the mains cord will be firmly anchored.

The hole positions for the GPO can be marked out by using it as a template. It should be oriented as shown on Fig.4 (ie, with the Earth terminal towards the bottom). The entry holes for the Active, Neutral and Earth leads must be fitted with small rubber grommets to protect the lead insulation.

Right angle bracket

As can be seen from the photographs, a right angle bracket was fitted to the rear panel of the prototype, just above the GPO. This bracket is secured to the rear panel by the top GPO mounting screw and to the lid using a screw and a captured nut. This was done to add rigidity to the aluminium rear panel on the prototype, to prevent flexing as the plug is pushed in and out.

If a metal diecast case or a steel case

PARTS LIST

1 PC board, code 10304951, 76 x 127mm
1 front panel label, 100 x 52mm
1 metal cabinet, 100 x 60 x 150mm or similar
1 10A panel mount mains socket (HPM Cat. N0 35 or equivalent)
1 12-position single pole rotary switch (S1)
2 SPDT toggle switches (S2,S4)
1 momentary pushbutton normally open switch (S3)
1 SPST mains rocker switch with integral Neon (S5)
1 2851 12.6V 150mA mains transformer (T1)
1 M205 panel-mount fuse holder
1 M205 5A 250VAC fuse
1 10A 250VAC 2-way terminal block
1 14mm diameter knob
1 cord grip grommet for 10A mains flex
1 10A mains cord & plug
3 5.5mm ID grommets
1 right angle bracket plus screws & nuts (see text)
1 5mm LED bezel
1 solder lug
4 9mm tapped spacers
5 12mm x 3mm dia. screws & nuts
4 9mm x 3mm dia. screws & nuts
1 3mm dia. star washer
1 30mm length of 6-way rainbow cable
2 30mm lengths of 6-way rainbow cable
1 120mm length of blue hookup wire
1 120mm length of red hookup wire
1 120mm length of yellow hookup wire
1 200mm length of brown 10A mains wire
1 100mm length of blue 10A mains wire
1 50mm length of 0.8mm tinned copper wire
5 100 x 2.4mm cable ties
1 70mm length of 19.1mm diameter heatshrink tubing
25 PC stakes
1 5kΩ miniature horizontal trimpot (VR1)

Semiconductors
1 TLC555CP, LMC555CN, 7555 or equivalent CMOS timer (IC1)
1 MOC3021 opto-isolated Triac driver (IC2)
1 WO4 1.2A 400V DIP bridge rectifier (BR1)
1 7812, 12V 3-terminal regulator (REG1)
1 MAC320A8PF 8A isolated tab Triac (TR1)
1 BC338 NPN transistor (Q1)
1 5mm diameter red LED (LED1)

Capacitors
1 470µF 25VW PC electrolytic
1 220µF 16VW RBLL electrolytic
1 22µF 35VW RBLL electrolytic
2 10µF 16VW PC electrolytic
2 0.1µF MKT polyester
1 0.1µF 250VAC plastic film
1 0.033µF 250VAC plastic film
Note: the 220µF capacitor should be selected so that its measured value is 9.5-10.5 times larger than the measured value of the 22µF capacitor.

Resistors (0.25W, 1%)

1 510kΩ	1 24kΩ
1 360kΩ	1 16kΩ
1 270kΩ	4 10kΩ
1 200kΩ	1 4.7kΩ
1 120kΩ	1 3.3kΩ
1 91kΩ	2 680Ω
1 62kΩ	1 470Ω
1 43kΩ	2 330Ω 1W
1 39kΩ	1 22Ω 1W
1 33kΩ	

Miscellaneous
Heatsink compound (for Triac), solder, heatshrink tubing.

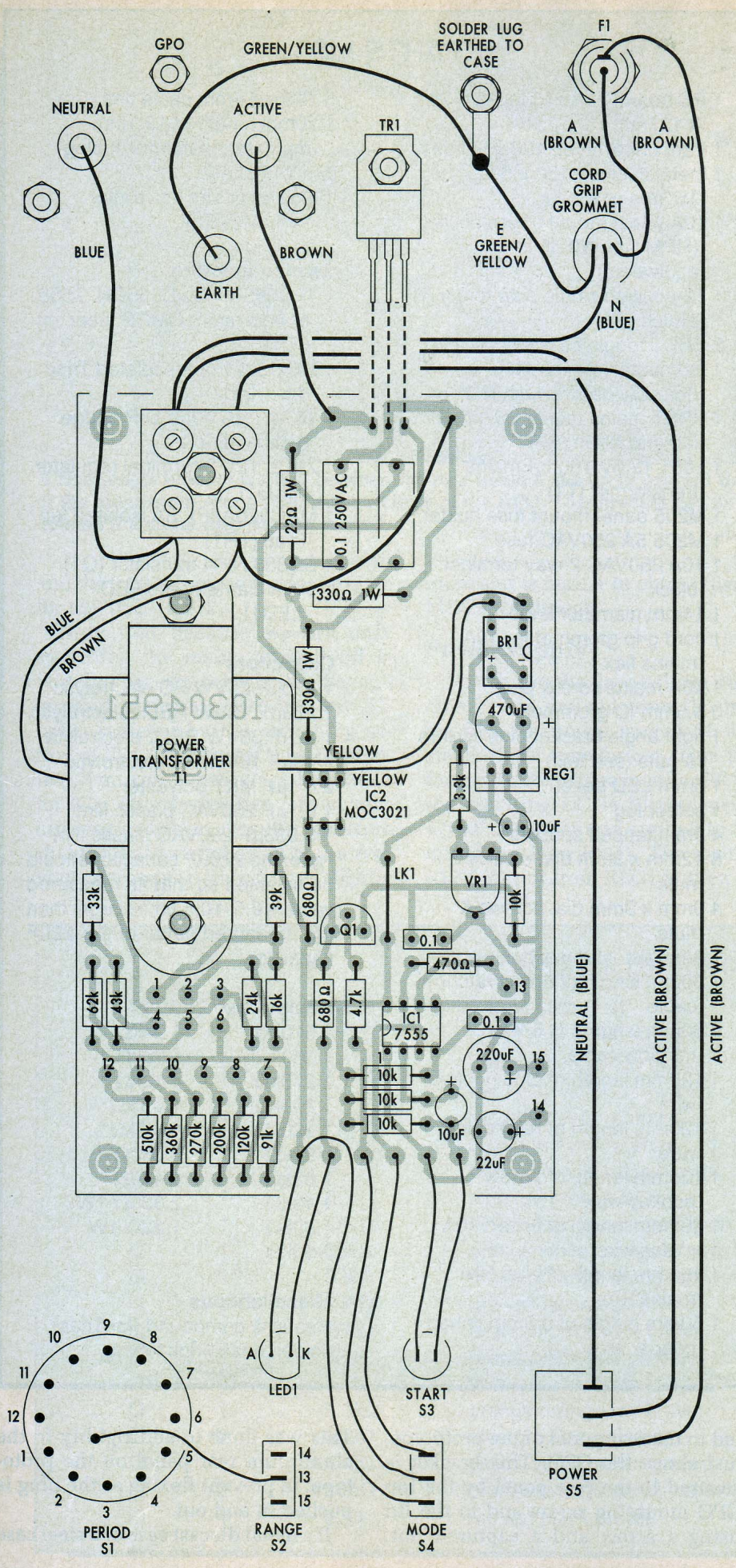


Fig.4 (left): follow this diagram carefully when wiring up the Photographic Timer & be sure to use mains-rated cable for all 240V wiring. The Triac (TR1) should be smeared with heatsink compound before it is bolted to the rear panel. Make sure that the earth lug is firmly secured.

is used, this bracket can be left out. However, it must be included where the rear panel is made from light-gauge aluminium.

The front panel label can now be affixed to the case and used as a template for drilling out the switch mounting holes. A hole will also have to be drilled to accept the LED bezel. The hole for the mains switch can be made by drilling a series of small holes around the inside perimeter of the cutout area, then knocking out the centre piece and carefully filing the hole to shape.

This done, mount the PC board in the case on 9mm spacers and install all front and rear panel components except for the rotary switch (S1). When mounting the earth solder lug, be sure to scrape away any paint from around the hole to ensure a good contact. The solder lug should be firmly secured using a star washer under the nut to prevent it from coming loose.

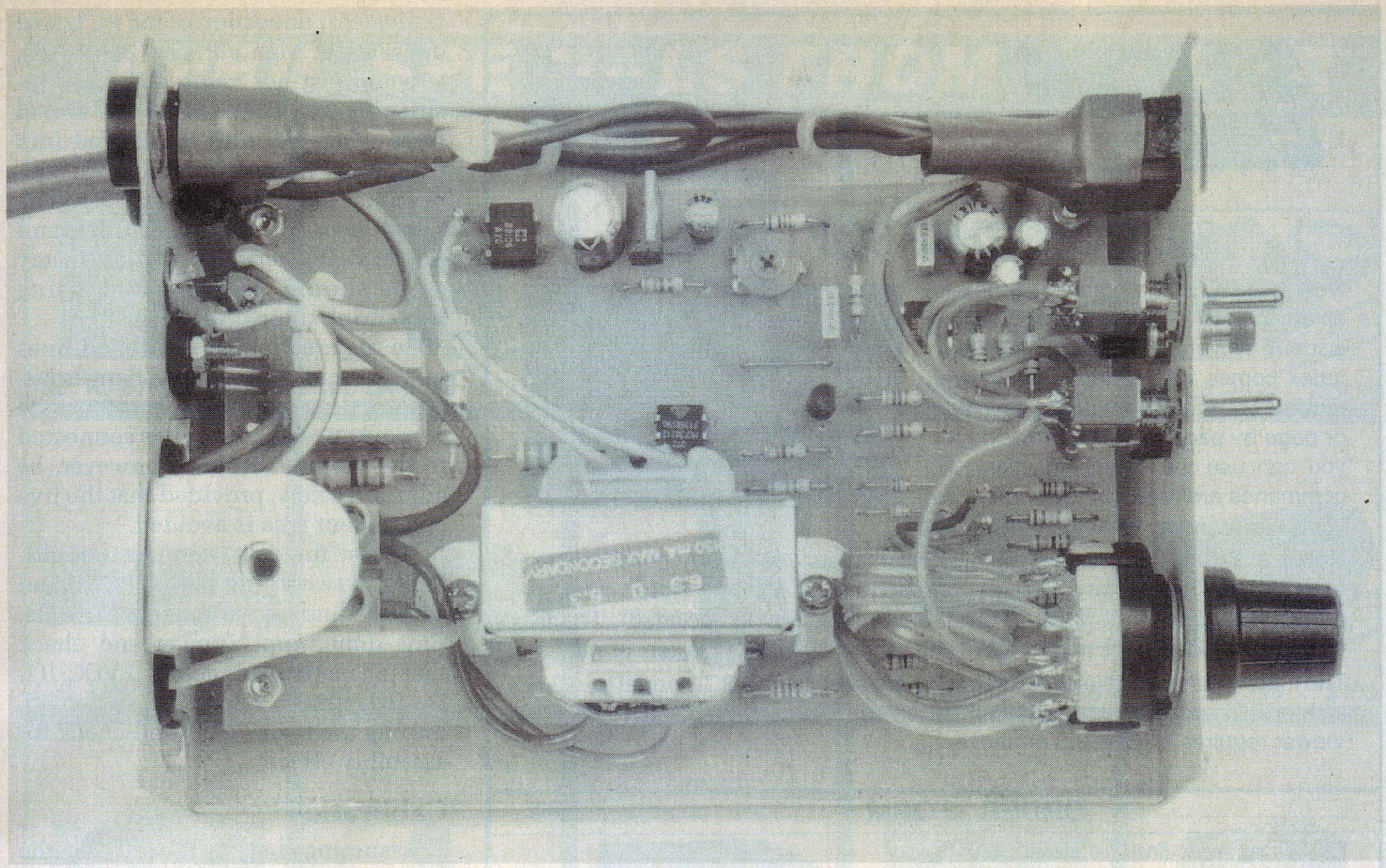
The Triac can be directly bolted to the case since its tab is isolated. Smear a small amount of heatsink compound between the mating surfaces before bolting it to the case to aid heat transfer. Warning: do not substitute a Triac with a non-insulated tab, as this will create a short between mains active and the case.

The shaft of the rotary switch can now be trimmed to suit the knob. In addition, its locking tab washer must be removed to allow the switch to select all 12 positions. This locking tab can be accessed by first removing the mounting nut and washer. Do not mount the switch yet, as it is easier to wire outside the case.

Wiring

The construction can now be completed by installing the wiring as shown in Fig.4. Rainbow cable is used for the connections to S1. Use a 6-way cable for pins 7-12 and two 3-way cables for pins 4-6 and 1-3.

When all the connections have been made, install the switch with the 6-



Use cable ties to keep the mains wiring neat & tidy & be sure to sleeve the fuseholder & power switch with heatshrink tubing to prevent accidental electric shock. Note that some components on the PC board operate at high voltage – see Fig.2.

way cable at the bottom and tighten the nut. Adjust the switch so that the marker on the knob aligns with the "1" on the front panel when the switch is fully anticlockwise. Don't forget the connection from S1's wiper to S2.

The connections to S2 and S4 are run using light duty hookup wire, while S3 only requires very short lengths of tinned copper wire to connect it to the board. Note that its terminals are bent sideways to prevent contact with other PC stakes. LED 1 has its leads connected directly to the PC stakes (note: the anode lead is the longer of the two).

The remainder of the wiring (ie, to the terminal block, fuseholder, power switch S5 and earth lug) must be run using mains-rated cable. Use brown cable for the Active connections, blue for Neutral and green/yellow for Earth.

Strip back about 130mm of the outer sheath of the mains cord before pushing it through the entry hole on the back of the case. This done, clamp the mains cord using the cord grip grommet and terminate the Earth lead to the solder lug. A second Earth lead must then be run from the solder lug to the Earth terminal on the GPO.

The wiring to the fuseholder and power switch can now be run. Before making these connections, slip some heatshrink tubing over the leads. After the connections have been made, push the heatshrink tubing over the switch and fuseholder bodies and shrink it down with a hot air gun (see photo). This will insulate the connections to these devices to guard against accidental contact.

Finally, complete the wiring to the terminal block and to the GPO, then secure the mains wiring with cable ties as shown in the photograph. The transformer secondary leads and the low-voltage wiring to S2 and S4 should also be secured using cable ties. This will prevent any accidental contact between the low-voltage and high-voltage sections of the circuit if a lead comes adrift.

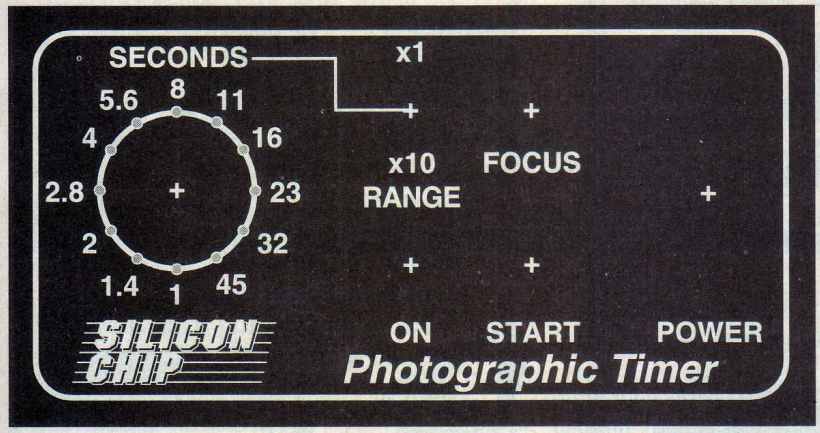


Fig.5: this full-size artwork can be used as a drilling template for the front panel. The warning label at right should be stuck to the lid of the case.

Testing

Exercise extreme caution when testing the Photographic Timer. As Fig.2

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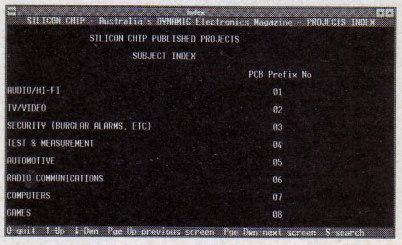

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indicates, **one section of the PC board operates at high voltage (240V AC), so you must not touch any parts inside the area enclosed by the dotted lines when the unit is plugged into the mains.** This includes the two connections on either side of TR1. The same goes for the fuseholder and power switch terminals which, in any case, should be insulated using heatshrink tubing (see above).

So the area inside the dotted lines on Fig.2 must be treated as dangerous. At no time should the circuit be worked on while the unit is connected to the mains. VR1 can, however, be adjusted safely, provided that the live component area is avoided.

To test the unit, connect a multimeter between the tab of REG1 and link LK1 and set the meter to DC volts. This done, apply power and check that the meter reads about 12VDC. If it is substantially below this, switch off, unplug the mains cord and check for assembly errors.

Calibration

Assuming that all is well, set the Focus switch to off, select the 16-second range (using S1 & S2), and press the Start button. Check that the LED immediately comes on and stays on for a short period of time. If it does, adjust calibration control VR1 on a trial and error basis until the period is exactly 16 seconds. Note: wind VR1 clockwise to increase the period and anticlockwise to decrease it.

If the LED fails to come on, switch the Focus on. If the LED now comes on, check the circuitry around IC1. Conversely, if the LED stays out, check transistor Q1 and the LED polarity.

Calibration on the x10 range position can now be checked. Provided that the timing capacitors have been properly selected, it should be within 5% of the expected value. If the period is too low and accuracy is critical, simply pad the 220µF capacitor until the correct period is obtained. This can be done by connecting a low-value (eg, 10µF) capacitor in parallel with the 220µF capacitor on the underside of the board (be sure to use a low-leakage type and don't forget to pull that mains plug from the wall).

Finally, attach the lid, plug a lamp into the output socket and check that it lights for the preset time when the Start button is pressed. The Photographic Timer is now finished. **SC**

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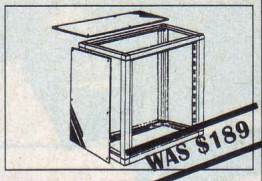

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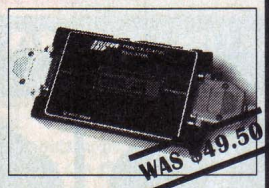

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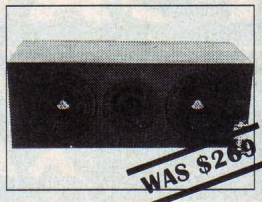

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See our new 1995 catalogue for full details.

TOOLCASE

NEW

This case opens up to reveal 4 trays which fold out and will hold parts, tools etc etc. Each tray has 2 dividers which can be adjusted to suit the user. The case is made from extruded aluminium edging and the sides are black aluminium. Total size - folded 220(D) x 360(L) x 240(H)mm.

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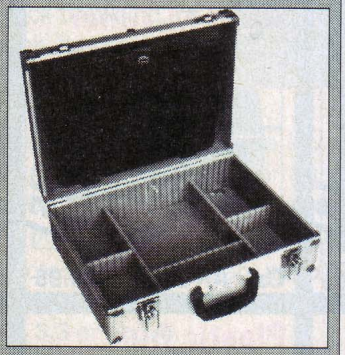

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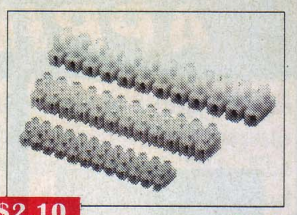

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Current - 0.1A	3V	SL-2671
	6V	SL-2673
	9V	SL-2674
All $0.95 each	12V	SL-2675

Small Size

Globe size - 3mm dia x 7mm	Volts	Cat
PVC lead length - 100mm	1.5V	SL-2680
Current - 0.1A	3V	SL-2681
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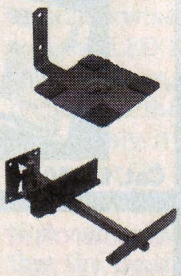

Plate size 150 x 150mm. Max weight 10kg each.

Cat. CW-2835 **$19.95 pr**

Adjustable units. Max weight 15kg.

Cat. CW-2840 **$29.95 pr**

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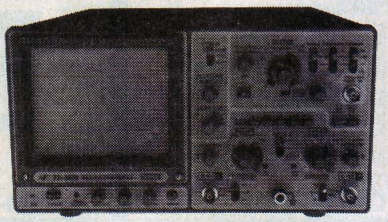
OSCILLOSCOPES



25mHz dual trace with delayed sweep

Cat. QC-1900 **$749**

Cat. QC-1910 **50mHz dual trace** **$1195**

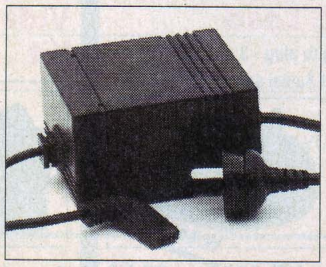
Cat. QC-1902 **Probes to suit** **$39.50ea**

Power Supply Bargain

240VAC to 20VAC @ 2 Amp

NEW

We have made a scoop purchase of a small quantity of desktop power supplies. Its is in a black box measuring 110 x 85 x 60(H)mm, and has a 2 metre 240V lead on the primary side, and a 2 metre lead on the secondary side which terminates to a strange plug. It is fully electricity authority approved. Quantity is small, so be quick.



Cat. MP-3029 **only $15 each**

Unidirectional Dynamic Mic

This is a unidirectional dynamic microphone and is excellent value for money. It has a plastic body with anti "pop" grill and the lead terminates to a 6.5mm mono plug. •Impedance: 600Ω •Freq resp: 80-12kHz

Cat. AM-4090 **$9.95** **was $15.95**

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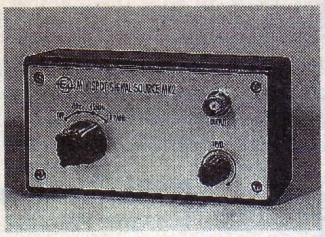
NEW KITS

Mini Spot AM/FM Alignment - Source Kit

NEW

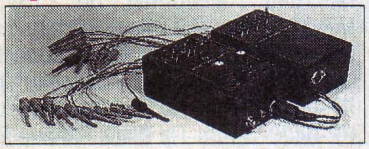


REF: EA 4/95

This kit will provide both a 455kHz signal for aligning AM radio IF strips and a 10.7MHz signal for doing the same job on FM radios. Both signals are modulated with an audio tone of around 1kHz, with the 1kHz audio signal available by itself for audio testing. The Jaycar kit is complete with PCB, case, silk screened front panel, plus all electronic components. Three AA penlight batteries required. Use Cat. SB-2354 Pk4

Cat. KA-1796 **$23.95**

Digital Trigger Adaptor Kit For CRO's



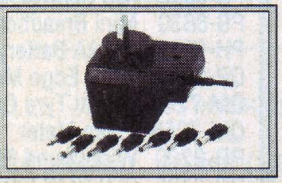
REF: EA 4/95

This project allows you to use your CRO more effectively with digital circuits by allowing you to monitor any given event in the circuit under test, and to trigger the scope only when all the relevant input conditions are met. With eight inputs (expandable to 24), it also includes an adjustable trigger delay, so it can effectively convert your scope into a low cost logic analyser. Kit is complete with PCB, case, screen printed front panel, IC test clips plus all electronic components.

NEW

Cat. KA-1772 **$55.00**

1 AMP PLUG PACK BARGAIN



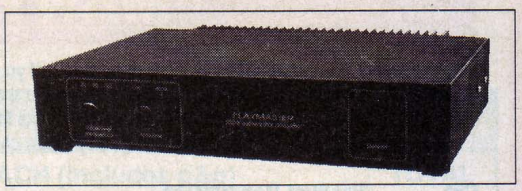
A 1 amp switchable plugpack is now available. 240V primary to 3v, 4.5v, 6v, 7.5v, 9v and 12vdc at 1 amp. Amazing price.

Cat. MP-3016 **only $29.95**

NEW KITS

Playmaster 300W Subwoofer Amp Kit

NEW



REF: ELECTRONICS AUST APRIL / MAY 1995

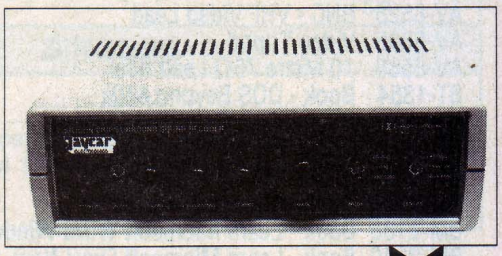
Cat. KA-1770 **$399**

Dolby Pro Logic Surround Sound Kit

REF: SILICON CHIP DEC 94 / JAN 95

DOLBY SURROUND PRO • LOGIC

Short Form Kit



This kit is supplied with pre-tinned PCB, Dolby ICs and all electronic components as per the Silicon Chip article, RCA socket bank, potentiometers, switches and internal audio and mains cable. The short form version of the kit is ideal for those constructors who wish to build a complete decoder with amplifier modules in the same case as the decoder (see the 'Boxes/racks' section).

NEW

Cat. KC-5175 **$169.50**

Enclosure Kit

This includes the low radiation toroidal transformer, mains lead and plug, fuse holder and fuse, mains switch, black anodised brushed aluminium instrument knobs, professionally punched and screened front panel, punched rear panel plus all mounting hardware.

Cat. KC-5176 **$69.50**

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REMOTE CONTROL SWITCHES

LATCHING UNIT:

NEW

This unit has both Normally Open and Normally Closed contacts. When ON is pressed the N/O relay contacts will close and stay closed. The N/C contacts will open and stay open ie: switch the unit on. When OFF is pressed the closed N/O contacts will open, and the closed N/C contacts will open ie: switch the unit off. Ideal for switching on / off a home burglar alarm, house appliances etc.

Specifications:

•Receiver operating voltage: 11 to 15VDC •Transmitting distance: over 50 metres •Security code - DIP switch: user programmable •Relay contact:1A / 24VDC •Receiver contacts: N/O and N/C •2 transmitters and 1 receiver supplied

Cat. LR-8824 **$79.95** Spare transmitters Cat. LR-8825 **$23.95**

MOMENTARY UNIT:

This unit has two relays in the receiver. Both relays can be wired in either Normally Open or Normally Closed contacts wiring configurations. When the ON button is pressed Relay 1 will change over for one second. When the OFF button is pressed Relay 2 will change over for one second. Both buttons are momentary types. This unit can be wired to work switching both on and off either a normally open or a normally closed contact. Ideal for car central locking, car alarms, switch logic circuits, remote paging using 2 different buzzers etc etc.

Specifications: •R'cver operating voltage: 11- 15VDC •Transmitting distance: over 50 metres •Security code: DIP switch: user programmable •Relay contact: 5A / 120V

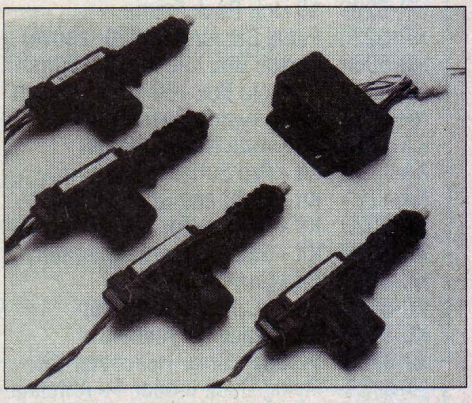
2 transmitters and 1 receiver supplied

Cat. LR-8826 **$99.95**

NEW

Spare transmitter Cat. LR-8827 **$23.95**

4 Door Car Power Door Lock Kit



If you own a 4 door car and want the convenience of power door locking, this is the kit for you. It consists of 2 master solenoids and 2 remote solenoids.

Suitable for connection to car alarms with negative triggering central door locking output. Full wiring harness to connect all 4 solenoids to the doors of even the biggest cars, all hardware.

Cat. LR-8830 WAS $119.50 **$95.00**

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JAYCARS DISCONTINUED PRODUCT SELLOUT

MANY ITEMS BELOW COST

Stock is limited, there may not be all items in all stores. If your nearest Jaycar Showroom has sold out of the item you want to purchase, you can phone **(02) 743 6144** and they will advise which stores had that patricular product in stock at the beginning of the sale. You can also phone around yourself, or you can place an order with our Mail Order Department on **(02) 743 6144**, using a credit card and we will do the finding for you and send you the goods (plus post and packaging) if they are still available. For full specifications and descriptions on most of the products listed below check our 1994 catalogue. Be quick, stock is limited and wont last. Goods not available at Dealers at these prices

Cat	Product Description	Was $	Now $
AM-4210	LAD Disco Turntable	229.00	179.00
AV-6522	Scart Lead to 4xRCA / 2xBNC	19.95	15.00
AV-6526	Mini 8 Din to 6 Pin Din Lead	12.95	8.95
AV-6527	Mini 8 Din to Scart plug	11.95	7.95
AV-6528	BNC - VHF Video Lead	2.95	1.00
AV-6535	Video Tripod	59.95	39.95
AV-6588	10 Metre 75Ω Lead Reel	16.95	10.00
BT-1354	Book - DOS Beyond 640k	49.95	20.00
BT-1370	Book - Repair Home Appliances	23.95	10.00
BT-1372	Book - PC Made Easy Vol.12	46.95	20.00
BT-1374	Book - Best Mac Tips Ever	39.95	20.00
BM-2128	Book - Microsoft Norton	7.95	2.00
BM-2138	Book - Learn Microsoft Word Windows	19.95	10.00
BM-2140	Book - Learn Microsoft Excel Now	29.95	10.00
BM-2142	Book - Learn Microsoft Word Now	29.95	9.95
BM-2144	Book - Supercharging MS DOS	12.95	2.00
BC-3044	Book - Buy & Understand Computers	19.95	5.00
BW-3504	Book - Virtual Reality Playhouse	47.95	20.00
BW-3512	Book - Make Movies On Your PC	69.95	25.00
BW-3518	Upgrade and Maintain Your PC	69.95	30.00
BB-3800	Book - 12 Volt Doctors Alternator	32.95	20.00
BB-3802	Book - 12 Volt Doctors Projects	22.95	12.00
BB-3804	Book - 12 Volt Doctors H/B for Boats	39.95	20.00
BB-3806	Book - Marine Electrical	49.95	25.00
BX-3904	Book - Intro. Circuit Analysis	59.95	30.00
BM-4570	Book - 1992 Jap Trans. Sub Manual	17.95	10.00
BM-4572	Book - 92 Jap Trans. Data Manual	19.95	10.00
BM-4574	Book - Jap Diode Data Manual	19.95	10.00
BC-6000	Folded Giant Data Wallchart	12.95	6.95
CG-2385	12"Jet Musical Inst. Spk. 200W	229.00	139.00
CX-2605	2 Way Car X-over 3Khz 150W	22.95	15.00
CX-2606	2 Way Car X-over 500Hz 150W	32.95	20.00
HP-0290	6BA Flat Washer Pkt. 50	1.60	1.00
HP-0469	4mm S/Proof Washer Pkt. 200	9.95	4.95
HP-0640	M-6 Captive Nut Pkt. 12	6.50	3.50
HP-0645	M-6 16mm Bolt Silver Pkt. 12	2.95	1.50
HP-0646	M-6 16mm Philips Black Pkt. 12	2.95	1.50
HP-1120	TO3 Micro Insul. Kit Pkt. 100	19.95	10.00
HP-1151	TO3 Rubber Washer Pkt. 100	25.95	16.95
HR-5220	18 Unit Rack Frame	189.00	129.00
HR-5225	Panel Set for HR5220 (above)	110.00	65.00
HB-5506	Plastic Box 190 x 110 x 90mm	8.95	5.00
HB-5512	Console Box 160 x 50 x 95mm	5.95	3.50
HP-9565	Proto-typing Board	39.95	27.50
KA-1718	Kit - Auto Nicad Charger	39.95	20.00
KA-1730	Kit - Pro Series 2 Pre Amp	329.00	249.00
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KC-5029	Kit - Remote for Train Controller	149.95	89.95
KC-5079	Kit - Sine / Square Generator	159.50	119.50
KC-5129	Kit - Camcorder Mixer	29.95	15.95
KC-5145	Kit - LCD Print Indicator	69.50	39.50
KC-5149	Kit - Voice OP Audio Sw	14.95	6.00
KJ-6760	Wooden Solar Helicopter Kit	26.95	14.95
LT-3135	Flying Duck Indoor TV Antenna	29.95	20.00
LT-3155	Hi Gain Fringe UHF / VHF	199.50	150.00
LT-3188	UHF Parabolic Antenna	29.95	19.95
LA-5008	PIR Night Light	29.95	19.95
LA-5040	Outdoor Infrared Alarm Beam	129.50	89.50
LA-5112	Alarm - Siren / Metal Cover / Strobe	59.95	49.95
LA-5132	Outdoor Motion Detector / Light Par	39.95	29.95
LA-5195	Glassbreak Detector	79.95	40.00

Cat	Product Description	Was $	Now $
LA-5202	Economy Wireless Zeus Panel	249.00	69.00
LA-5290	16VAC SLA Battery Charger	39.95	20.00
LR-8823	Spare TX for LR8822 Remote	22.95	12.00
LA-8902	Car Alarm - One Door Locking	199.50	149.50
LA-8905	Car Alarm - Four Door Locking	259.00	199.50
MF-1040	Transformer - Sec - 13V + 36V	10.00	5.00
MP-3112	Novatel Phone Battery Eliminator	29.95	10.00
MS-4000	IEC In Line Mains Connector	24.95	20.00
MS-4025	Mains Filter - Squeeky Clean	149.50	129.50
PP-0418	2mm Tip Red Banana Plug	1.65	0.50
PP-0420	2mm Tip Black Banana Plug	1.65	0.50
PP-0605	75Ω Solderless Rapid Plug	2.95	0.50
PS-0615	75Ω Solderless Rapid Socket	2.95	0.50
PS-0661	BNC Right Angle Socket	3.20	0.80
PP-0684	PL259 Reducing Adaptor	0.75	0.20
PA-0889	Backshell for Commodore Connector	2.95	0.40
PS-0896	IDC Centronics Panel Skirt	6.95	1.00
PB-8830	Mini Breadboard - 100 Hole	5.95	3.95
PH-9225	4 x AA Battery Stacker	1.50	0.50
QP-5060	100V Edge Meter	9.95	5.00
QM-7240	Digital Tyre Gauge	29.95	20.00
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RR-3200	Wirewound Resistor Pack	12.50	8.50
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RC-5500	2UF 440V Modem Cap	5.95	2.95
SS-0858	SPST Black Slider Sw	0.95	0.20
SK-0951	SPDT C/Off 250V 5A Sw	2.50	1.00
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TS-1461	1mm Tip for Old Model TS1460 Iron	9.95	5.00
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YP-5000	8" Plasma Lamp	129.50	80.00
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ZR-9500	PIR Sensor	12.95	6.00

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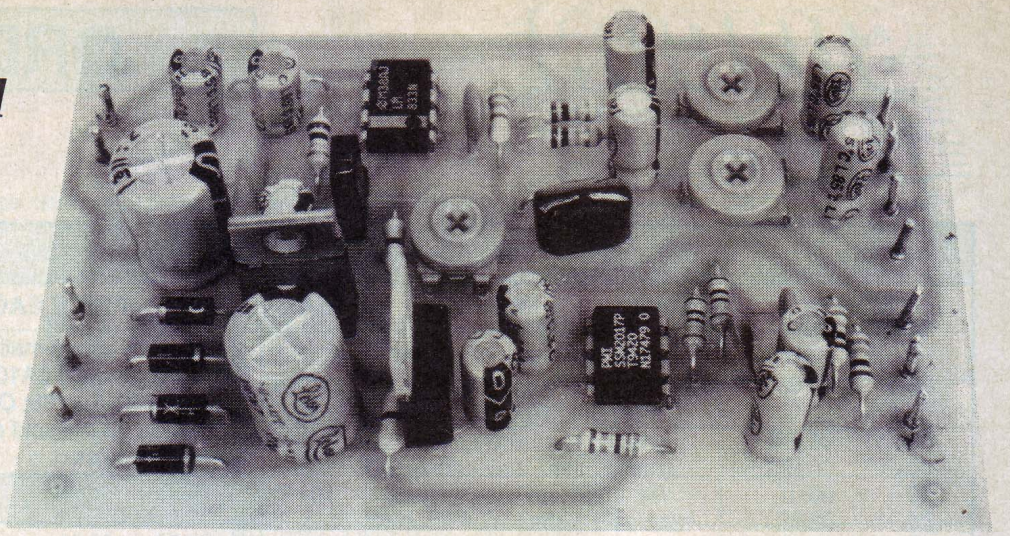
This multipurpose circuit is a balanced microphone preamplifier & line input mixer. It can operate from a variety of AC & DC supply voltages & has low noise & distortion.



By LEO SIMPSON

Balanced microphone preamplifier & line mixer

All professional public address systems use balanced microphone lines. These have the advantage of considerable immunity from hum and noise even when long lines are necessary. The disadvantage is that the preamplifier requires either an expensive balanced-to-unbalanced transformer or a fairly complex circuit involving two or three low noise op amp ICs.

This project gets around that problem by using the SSM2017 IC from Analog Devices. This chip has been specially designed as a balanced microphone preamplifier. The resulting circuit has high gain, low noise and very low distortion.

As presented here, the preamplifier is a small PC board measuring 90 x 56mm. It has two ICs, two 3-terminal regulators and a number of trimpots for level setting. As well as providing a pair of balanced inputs for a low impedance microphone, it also has provision for two line-level inputs. Fig.1 shows the complete circuit.

Performance of Prototype

Microphone Input

Gain	59.5dB
Signal-to-noise ratio	-74dB A-weighted with respect to 0.75mV input and 1V output; -71.5dB unweighted (22Hz to 22kHz); both measurements taken with a 50Ω balanced source.
Frequency Response	180Hz to 20kHz, +0dB & -3dB

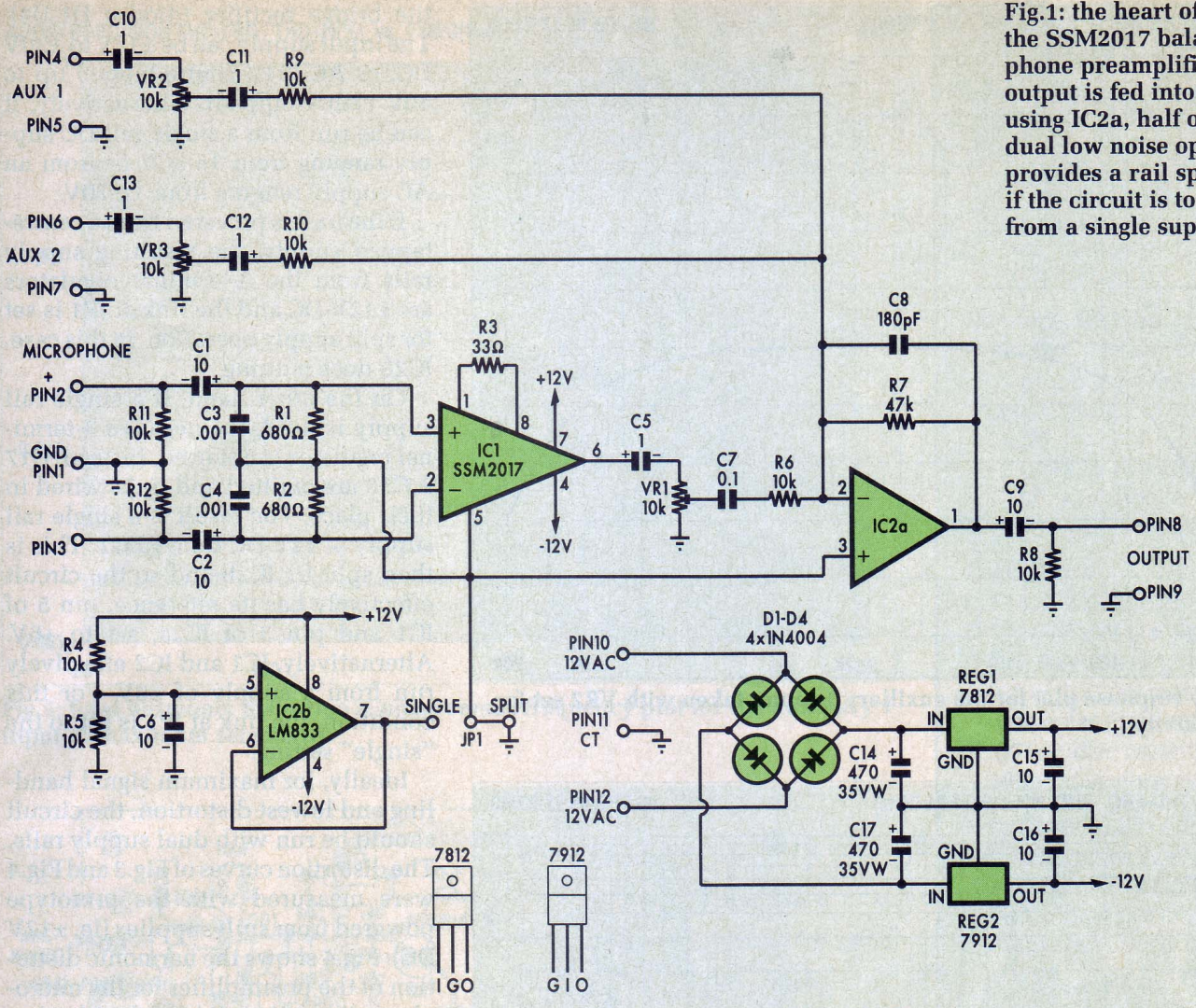
Auxiliary Inputs

Gain	13.5dB
Signal-to-noise ratio	-98.7dB A-weighted with respect to 0.24V input and 1V output; -96.7dB unweighted (22Hz to 22kHz); both measurements taken with a 600Ω unbalanced source.
Frequency response	30Hz to 20kHz, +0dB & -3dB

Circuit operation

IC1, the SSM2017 balanced microphone preamplifier, requires very few external components for its basic operation and its gain is set to 200 (+46dB) by the 33Ω resistor (R3) between pins 1 & 8. The balanced input is AC-coupled via 10µF capacitors C1 & C2 which are there to block any DC signals and also to prevent any DC being applied to the microphone if the circuit is operated in single-supply mode. We'll explain that point in a moment.

The input impedance is set to about 1.3kΩ by two 680Ω resistors (R1 & R2), while C3 & C4 attenuate unwanted signals above the audio passband. The output of IC1 is AC-coupled by a 1µF capacitor to trimpot VR1 which acts as the microphone level control.



BALANCED MICROPHONE PREAMPLIFIER

Fig.1: the heart of this circuit is the SSM2017 balanced microphone preamplifier (IC1). Its output is fed into a mixer stage using IC2a, half of an LM833 dual low noise op amp. IC2b, provides a rail splitting facility if the circuit is to be powered from a single supply rail.

Line level signals are AC-coupled to trimpots VR2 & VR3 and these act as mixing controls for these signals. All three signals are fed to op amp IC2a which is a conventional mixer stage with its gain set to 4.7, the ratio of the 47kΩ feedback resistor (R7) to the 10kΩ mixing resistors.

The total gain of the preamplifier is therefore close to 940 (+59.5dB) which is more than sufficient for most microphone applications.

The bass response of the preamplifier is curtailed below 300Hz and is -3dB down at about 180Hz, mainly due to the interaction of C7 with R6. This rolloff is desirable for most microphone applications to prevent pick-up of building rumble and also to prevent serious overload by users who tend to blow into microphones. This rolloff can be seen in the frequency response plot of Fig.2.

By contrast, the high level inputs have a more of less normal bass response, with the -3dB point at just

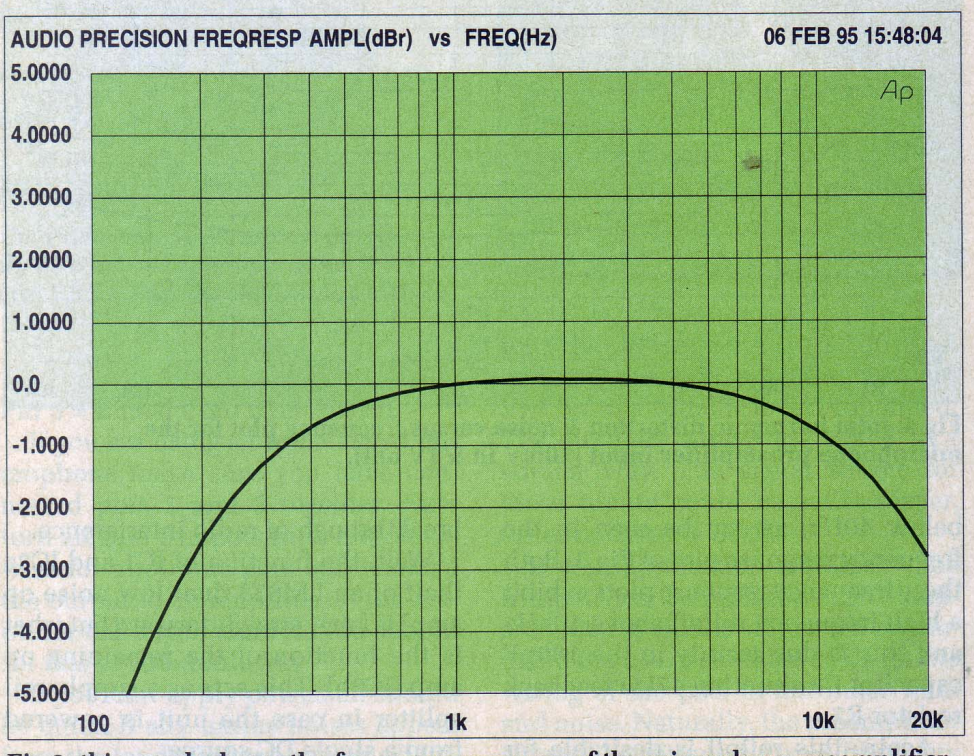


Fig.2: this graph shows the frequency response of the microphone preamplifier input, taken with VR1 set for maximum sensitivity. As shown, the response is 3dB down at 180Hz & 20kHz.

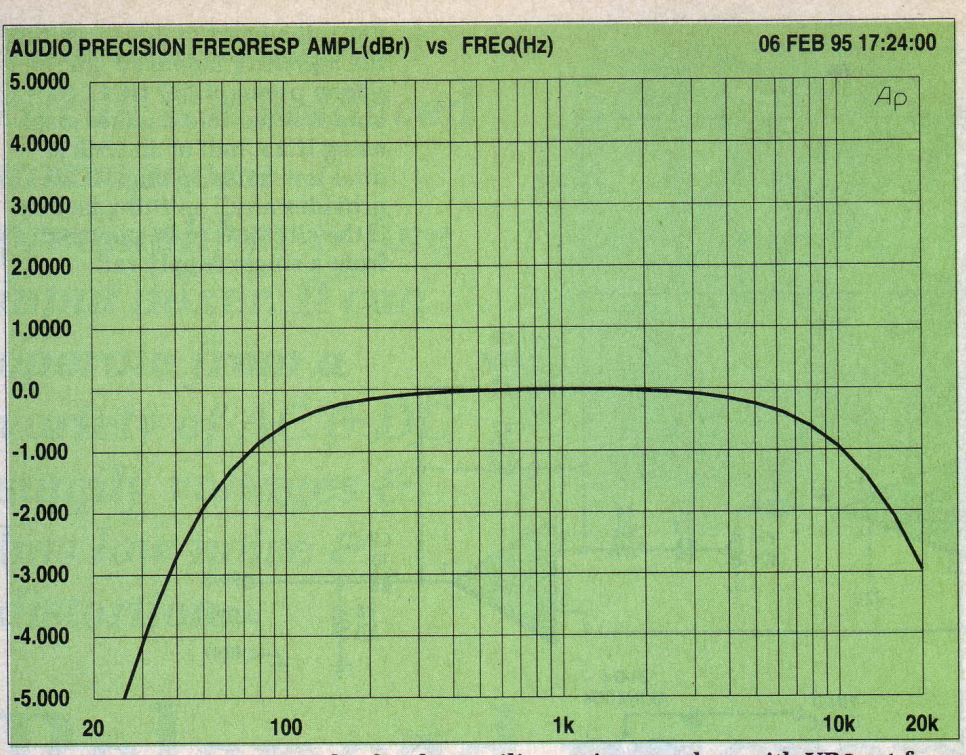


Fig.3: frequency response plot for the auxiliary 1 input, taken with VR2 set for maximum sensitivity.

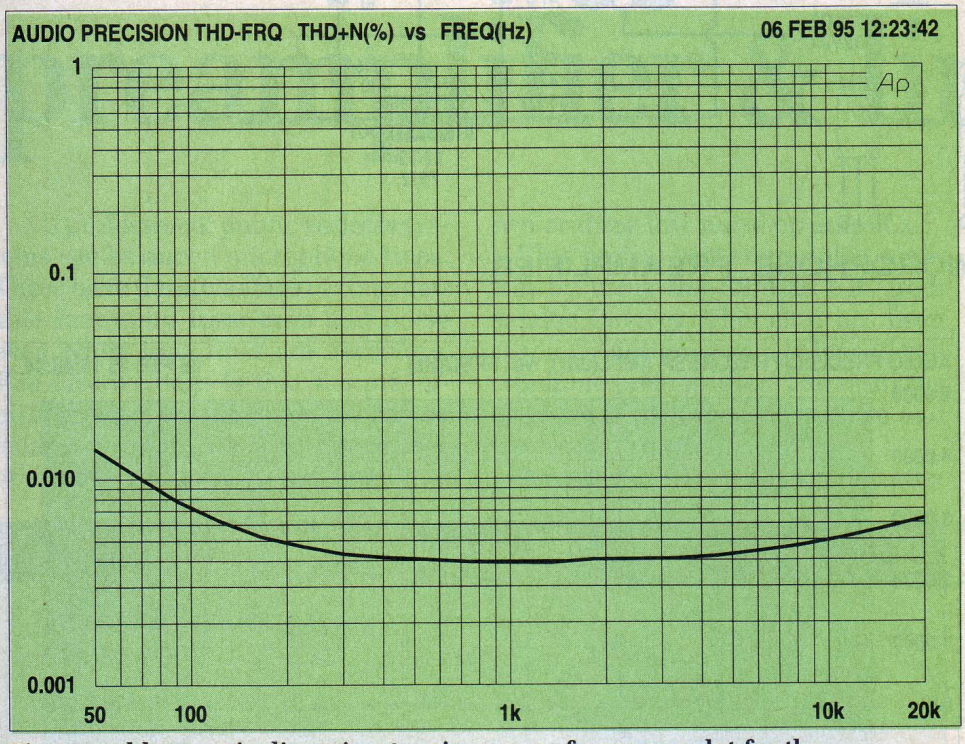


Fig.4: total harmonic distortion & noise versus frequency plot for the microphone preamplifier input (10mV in & 1V out).

below 40Hz, as can be seen in the frequency response plot of Fig.3. Both these frequency response plots exhibit a high frequency rolloff above 10kHz and this is due mainly to the 180pF capacitor C8 shunting 47kΩ feedback resistor R7.

Again, this rolloff is desirable for public address work, to keep noise to a minimum and also to minimise breakthrough of radio interference.

Well, the function of IC1 and IC2a (half of an LM833 dual low noise op amp) is fairly straightforward but what is the function of the remaining op amp (IC2b). This acts as a supply rail splitter in case the unit is powered from a single DC source.

The power supply section can accept an AC or DC input by virtue of the bridge rectifier (diodes D1-D4). The input supply can be ±12V to ±30V DC, or AC (24V centre-tapped up to 40V centre-tapped). Alternatively, it can be run from a single rail DC supply ranging from 15-30V or from an AC supply ranging from 12-20V.

If the unit is powered from a centre-tapped supply, the resulting supply rails from the 3-terminal regulators are ±12V DC and the link at JP1 is set for split supply operation. In this case, IC2b does nothing.

On the other hand, if a single rail supply is used, the negative 3-terminal regulator is not used. Instead, C17 & C16 are omitted and links wired in their place. The result is a single rail supply of 12V DC from REG1. This is then split by IC2b and so the circuit effectively has its reference, pin 5 of IC1 and pin 3 of IC2a, set to +6V. Alternatively, IC1 and IC2 effectively run from a supply of ±6V. For this condition, the link at JP1 is set to the "single" setting.

Ideally, for maximum signal handling and lowest distortion, the circuit should be run with dual supply rails. The distortion curves of Fig.3 and Fig.4 were measured with the prototype powered from spilt supplies (ie, ±12V DC). Fig.4 shows the harmonic distortion of the preamplifier for the microphone input (10mV in and with trimpot VR1 set for 1V out). Both VR2 & VR3 were set to maximum attenuation.

Fig.5 shows the harmonic distortion of the preamplifier for one of the line inputs. In this case, VR1 was set to zero, while the line input in question was 0.24V in and 1V out.

Construction

Assembly of the PC board is quite straightforward. We suggest installing the 12 PC pins and the 3-pin header first, followed by the links, resistors and diodes. This done, install the trimpots, the capacitors, ICs and regulators. Make sure that all polarised parts such as the electrolytic capacitors, diodes and other semiconductors are installed the right way around. If you don't make sure of this point, the circuit could be damaged when power is applied for the first time.

Before applying power to the finished board, check your work carefully to make sure that all components are correctly installed and that there are no solder bridges or missed

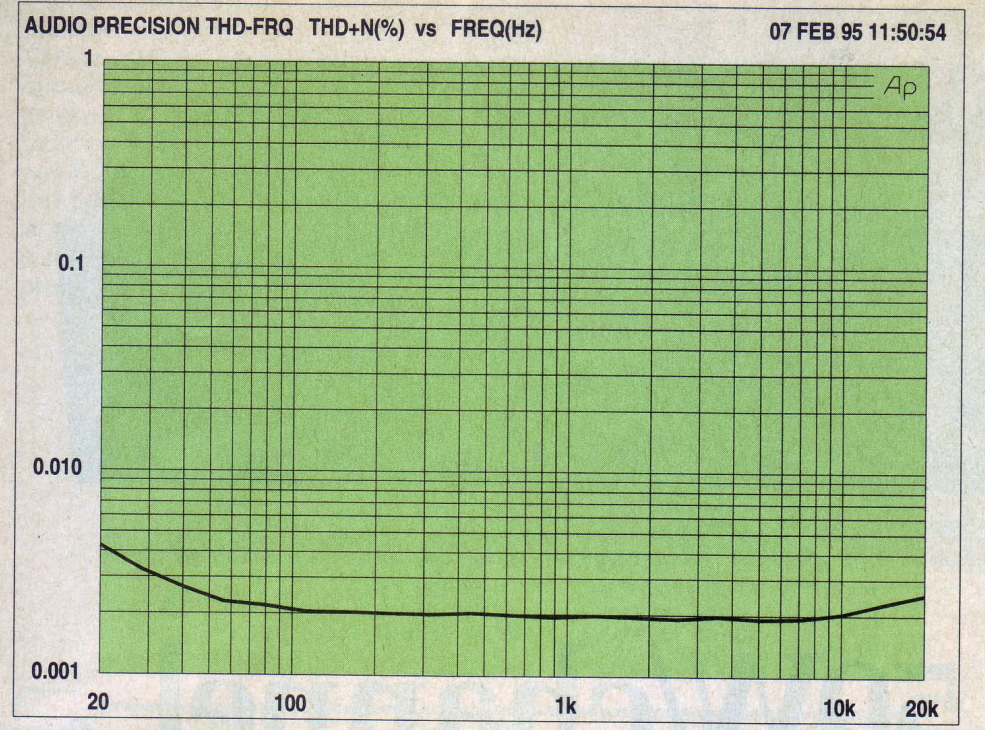


Fig.5: total harmonic distortion & noise versus frequency plot for the auxiliary 1 input at maximum sensitivity.

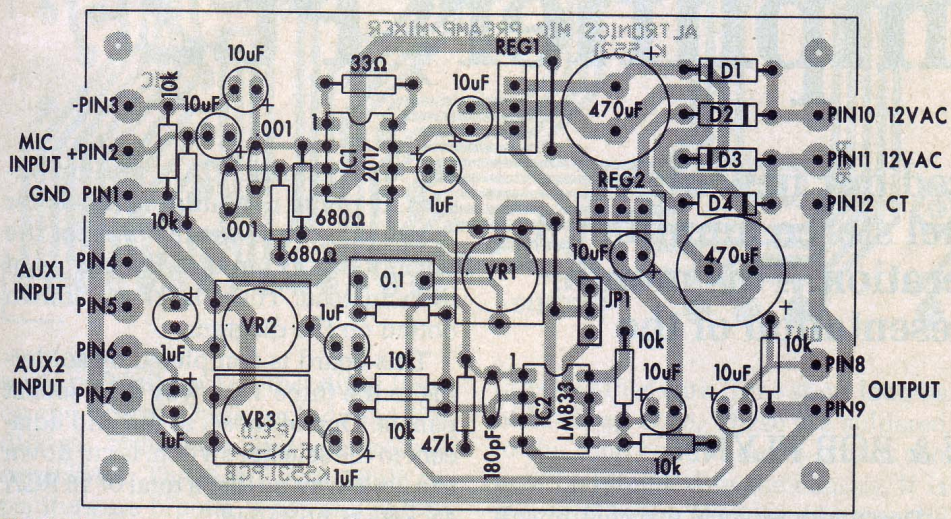


Fig.6: the component overlay diagram for the PC board. Make sure that the jumper is correctly installed for dual supply or single supply operation. VR1 sets the level for the microphone input, while VR2 & VR3 set the levels for the two auxiliary inputs.

PARTS LIST

1 PC board, code PED5531, 90 x 56mm
12 PC pins
1 3-pin header (JP1)
1 mini jumper
3 10kΩ horizontal trimpots (VR1-VR3)

Semiconductors
1 SSM2017 balanced microphone preamplifier (IC1)
1 LM833 dual low noise op amp (IC2)
1 7812 +12V regulator (REG1)
1 7912 -12V regulator (REG2)
4 1N4004 silicon diodes (D1-D4)

Capacitors
2 470µF 35VW electrolytic
6 10µF 35VW electrolytic
5 1µF 63VW electrolytic
1 0.1µF 100VW metallised polyester (greencap)
2 .001µF disc ceramic
1 180pF disc ceramic

Resistors (0.25W 5%)
1 47kΩ (yellow violet orange gold)
8 10kΩ (brown black orange gold)
2 680Ω (blue grey brown gold)
1 33Ω (orange orange black gold)

Where to buy the kit

This preamplifier has been designed and produced by Altronics. The kit is priced at $27.50 (Cat. K-5531) and is available from Altronics in Perth or from any of their resellers.

Note: copyright© of the PC pattern associated with this design is retained by Altronics.

solder joints on the underside.

If the unit is to be powered from a single supply, the 7912 regulator can be omitted and links installed in place of electrolytic capacitors C16 & C17. Make sure that the jumper has been set correctly as well.

Testing

Connect a microphone to the microphone input, making sure that the correct pins are used:
Pin 1 = Ground/Shield
Pin 2 = Signal Hot (In Phase)
Pin 3 = Signal Cold (Out Phase)

If you are using an unbalanced microphone make sure you have connected pins 1 and 3 together. Now turn all gain trimpots fully anticlockwise for minimum gain and connect the output to an amplifier. If the amplifier has a gain control, you should set this to about midway.

If you now apply power, all should be quiet. If any undue noises appear from the loudspeakers, switch off immediately and check your work carefully. All seems OK? Whilst talking into the microphone, you can then increase the gain adjusting trimpot VR1, until a suitable level is obtained. The auxiliary inputs are tested in a similar way. The signal source for these inputs could be a CD player, tuner or cassette deck.

If your application requires it, the trimpots can be replaced with standard pots. If this is done, we recommend the use of shielded cable for the wiring of the pots to minimise hum and noise. Naturally, the preamplifier should be situated away from any power transformers to minimise hum pick-up. **SC**

Build a 50W/channel stereo amplifier; Pt.2

Last month, we introduced our new high performance 50W/channel stereo amplifier & described the circuit operation. This month, we conclude with the presentation of the construction details.

By LEO SIMPSON & BOB FLYNN

Most of the construction of the new amplifier is quite straightforward. The work mainly involves mounting components on the five printed circuit board assemblies. These are the power amplifier board, the input selector board, the selector switch board, the tone control board and the optional RIAA preamp board.

The first job is to assemble the input selector board which is shown in Fig.7(a). This board is coded 01103951 and carries the RCA input and output sockets. Before mounting any of the parts, it is a good idea to carefully check the copper pattern on the underside of the board. You should especially check for shorts between the long parallel tracks to the selector switch.

Don't just rely on a visual check here – switch your multimeter to a high Ohms range and use it to confirm that the tracks are isolated from each other. This test will quickly locate faults on any board that has not been correctly etched. You will need to go through a similar checking procedure with each of the other boards when you come to them.

Now install the parts as shown in Fig.7(a). The first job is to install the 25 PC pins. Fourteen of these support the selector switch assembly and these should be installed from the copper side of the PC board; ie, so that the shoulder of each pin sits against its respective copper pad. The remaining pins are located at the left and right channel outputs, the tape inputs and the optional RIAA preamp inputs. If you're not building this latter board, you can forget the pins for the preamp inputs but install a couple of links instead. These links are shown dotted on the diagram.

This board is completed by soldering in the three 3 x 2-way RCA socket panels. One of these, at the end adjacent to the selector switch, is cut down to a 2 x 2-way, so that a total of 16 RCA sockets is provided.

Fig.8(a) shows the selector switch board (code 01103952). Position the switch with the locating spigot towards the top and push the body of the switch all the way down onto the board before soldering the terminals. The pads along the bottom edge of the switch board can now be soldered to the 14 PC pins on the input selector board.

Tone control board

Fig.9(a) shows the parts layout on the tone control PC board (code 01103953). Commence assembly by installing PC pins at the external wiring points, then fit the wire links, resistors, capacitors and semiconductors. Check the orientation of polarised

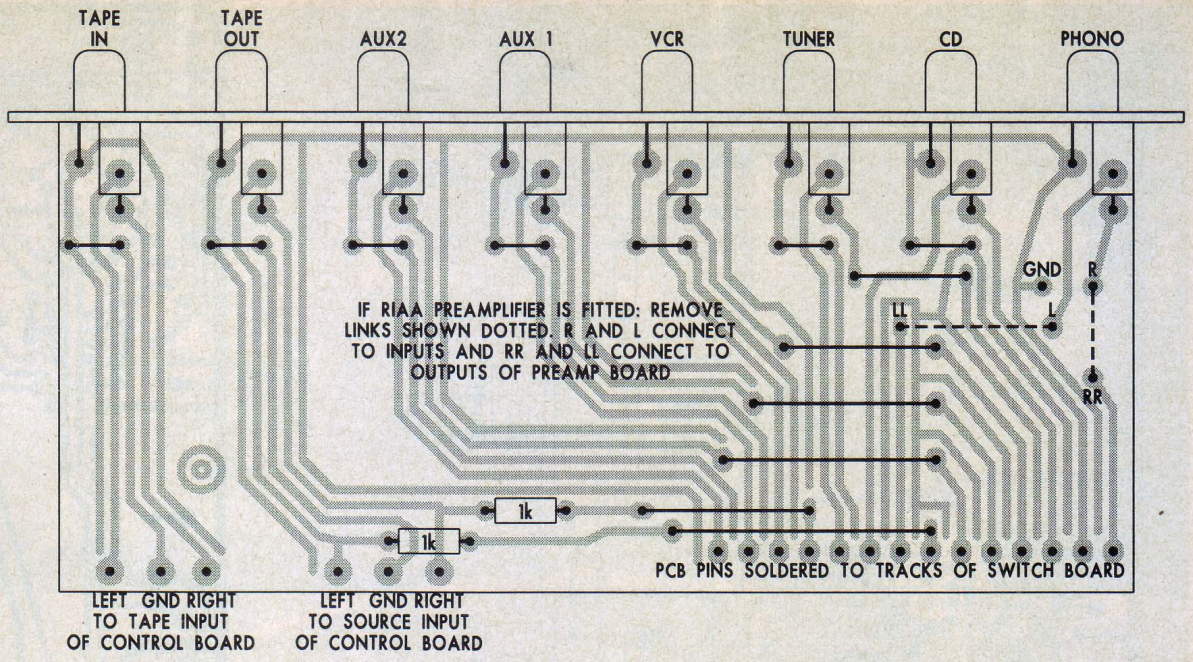


Fig.7(a): the input selector board. Note that if the optional RIAA preamp is not included in the amplifier, the two links shown dotted should be included & the associated PC pins omitted.

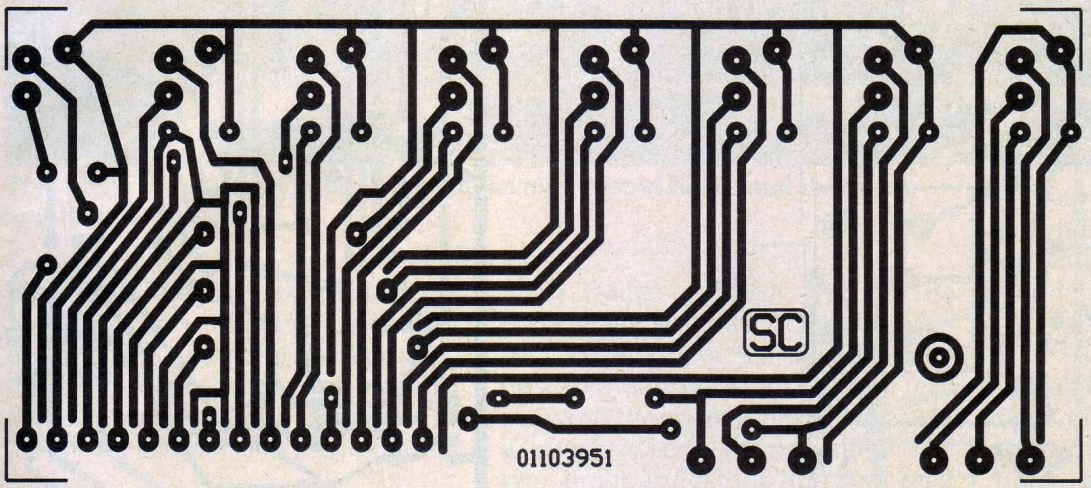


Fig.7(b): this is the full-size etching pattern for the input selector board.

parts carefully when installing them on the board. These include the ICs, diodes, transistors and electrolytic capacitors. The 6.8µF and 22µF capacitors are bipolar types and can be installed either way around.

The headphone socket, pots and pushbutton switches should be left till last. Be sure to push them all the way down onto the board but don't solder all the leads at this stage. Instead, tack solder diagonally opposite pins at either end of each component.

The tone control assembly can now be tested in the chassis to ensure that everything aligns properly. Adjust the alignment of the pots and switches as necessary before soldering the remaining pins.

Balance control

Fig.10 shows the wiring of the switch for the balance control. The resistors are wired around the switch pins together with three short lengths of hook-up wire. These are soldered to the tone control board which can now be mounted in the chassis. It is mounted to the front panel using the pot nuts and lockwashers. The rear of the tone control board is secured using two 12mm tapped spacers and screws.

Don't fit the dress panel to the chassis at this stage. It should be left in its protective wrapping for as long as possible, to protect it from scratches.

When all the pot nuts are secured, use your multimeter to check that all the pot cases are electrically connected together, via the chassis. If not, it might be necessary to remove the board from

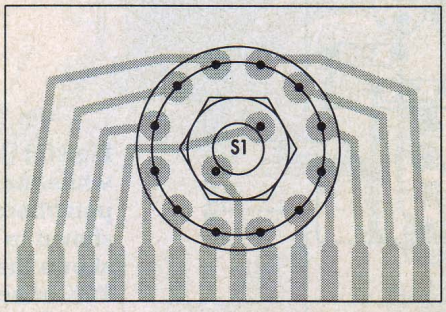


Fig.8(a): the selector switch board. This mates up to the 14 pins on the input selector board & is soldered at right angles to it.

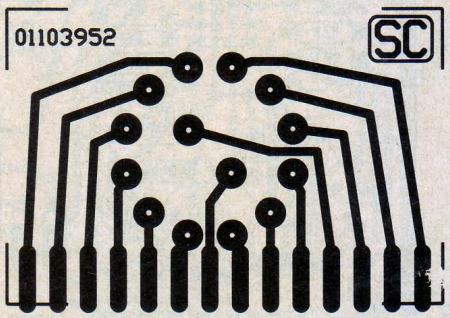
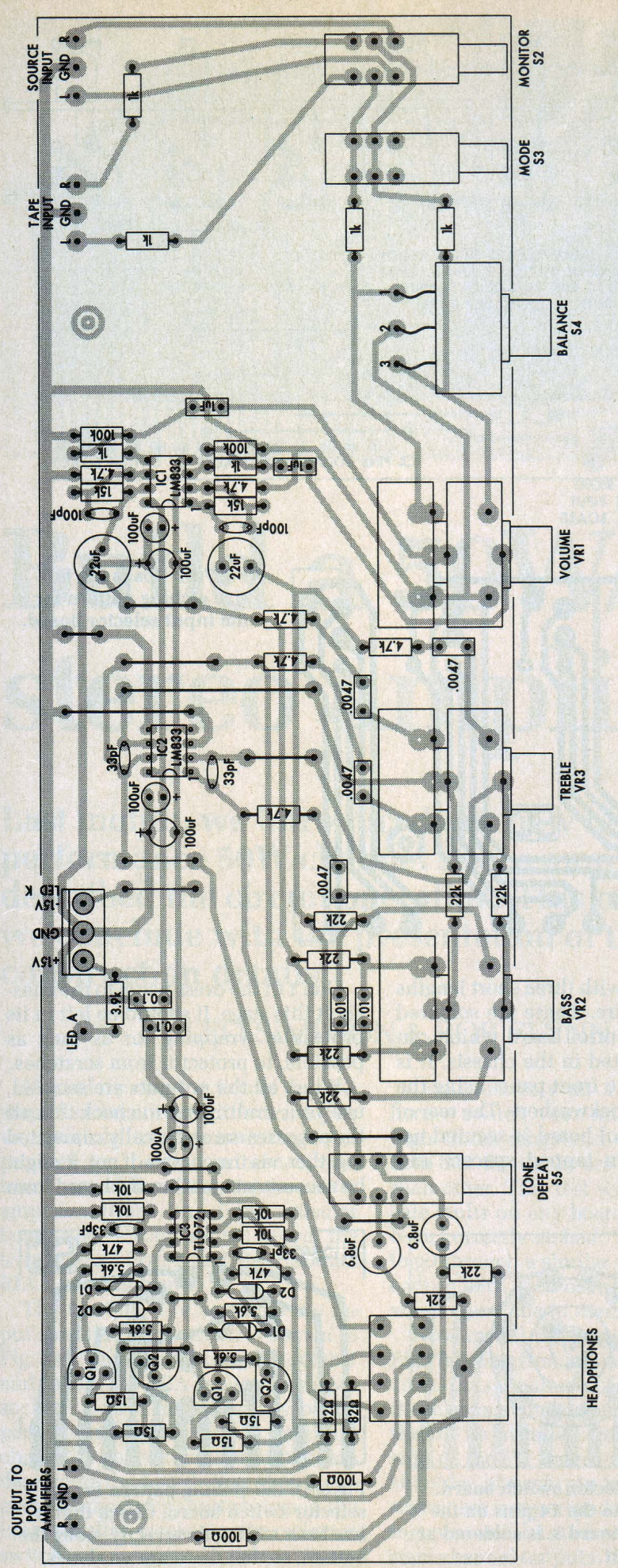


Fig.8(b): the etching pattern for the selector switch board. Check that it has been trimmed correctly along the bottom, so that there are no shorts.



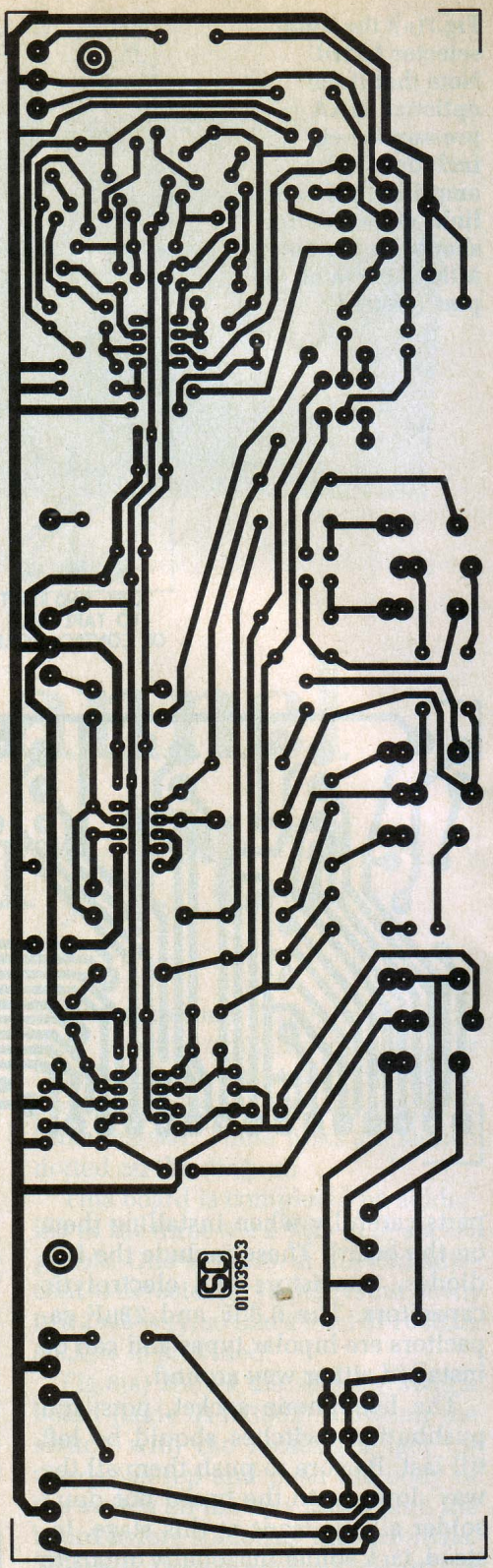
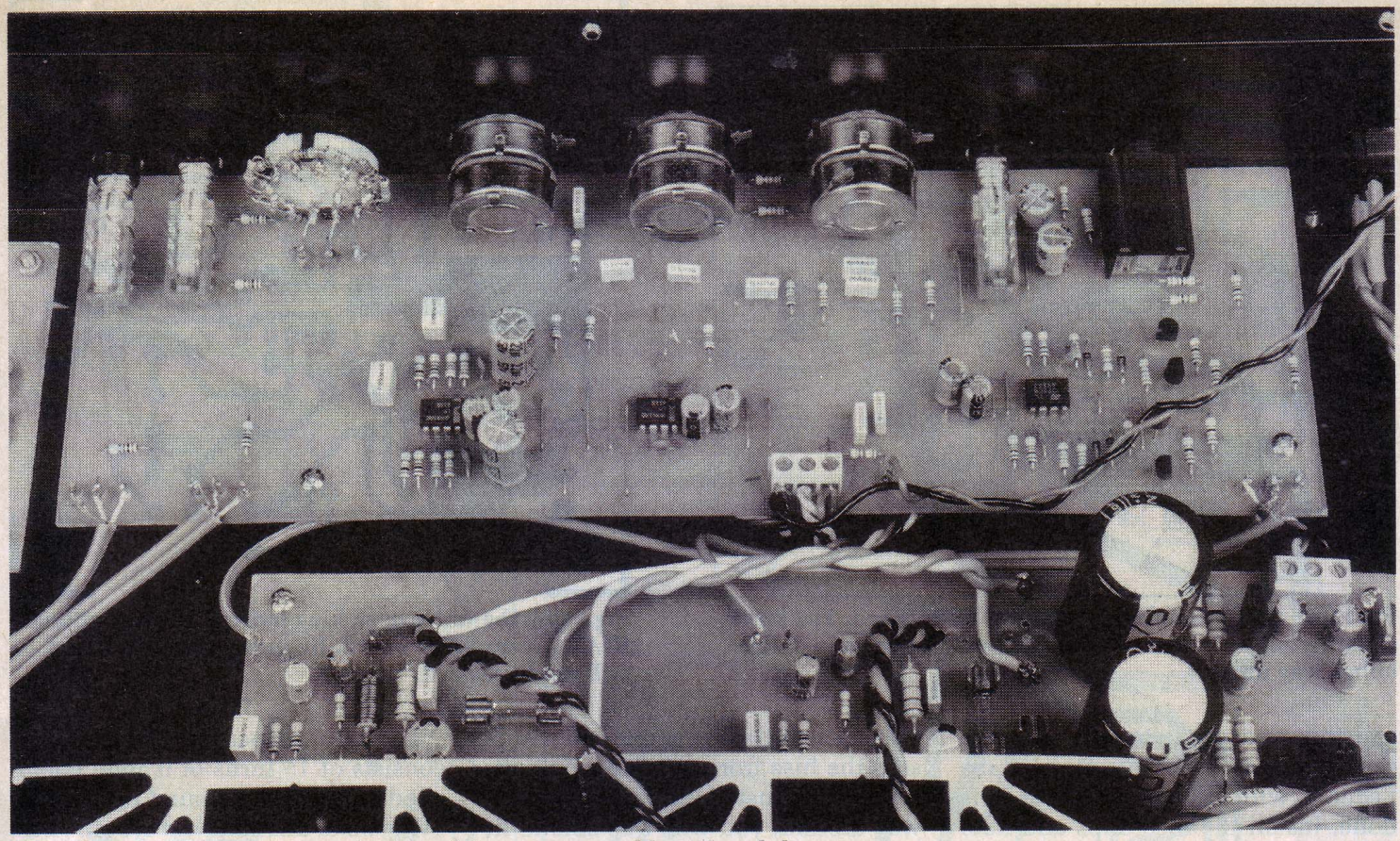


Fig.9(a) (left): the tone control board. Note that while the balance control (S4) looks like a single potentiometer, it is actually a rotary switch, as shown in Fig.10 on the facing page. Fig.9(b) (above) shows the PC pattern for this board. This is shown 70% of actual size & may be reproduced full size by enlarging it by a factor of 1.41 on a photostat machine.



This photo gives a good general view of the tone control board and the power amplifier board.

the chassis and then take a round file to lightly clean off any paint or anodising from around the pot mounting holes. The reason for making sure that the pots are properly earthed is to keep hum and noise to a minimum.

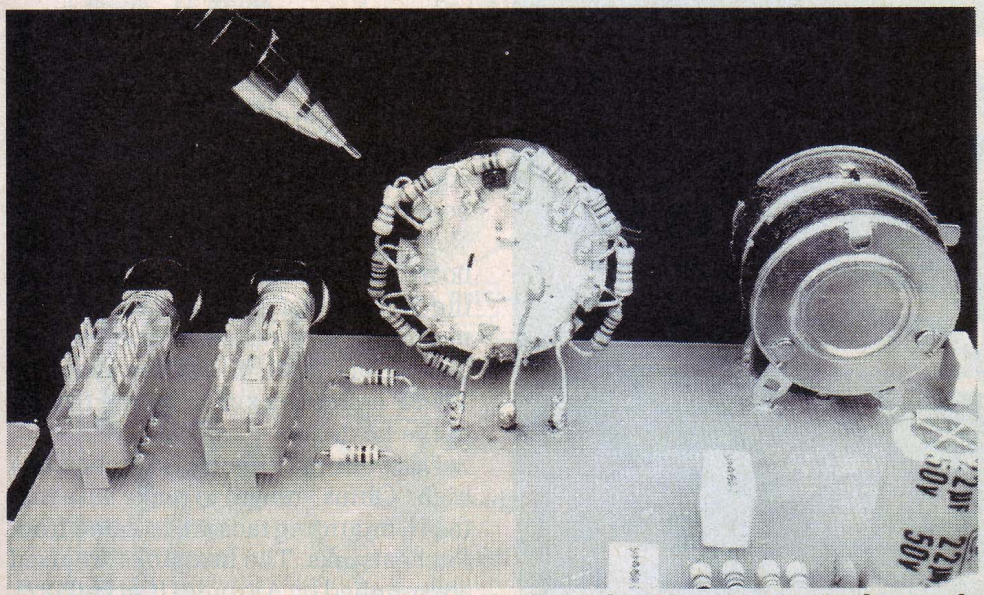
RIAA preamp board

As noted previously, this preamp board is optional and we assume that many readers will not need it. The parts layout is shown in Fig.11(a). It's best to start with the smaller parts (resistors and wire links) first. Take care with the orientation of the LM833 IC and the electrolytic capacitors. The two input inductors (L1) are each made by winding four turns of 0.4mm enamelled copper wire on a ferrite bead (Philips type 4330 030 3218).

Don't forget to strip the enamel off the ends of the lead wires before the inductors are soldered into the PC board.

Power amplifier board

This board is identical to that presented in the February 1995 issue but we are repeating the assembly instructions here for the sake of completeness. The component layout is shown in Fig.13(a). To begin, first install the PC pins and links, followed by the



The balance control is an 11-position rotary switch with resistors wired around its terminals. This arrangement gives much better separation between channels than a potentiometer.

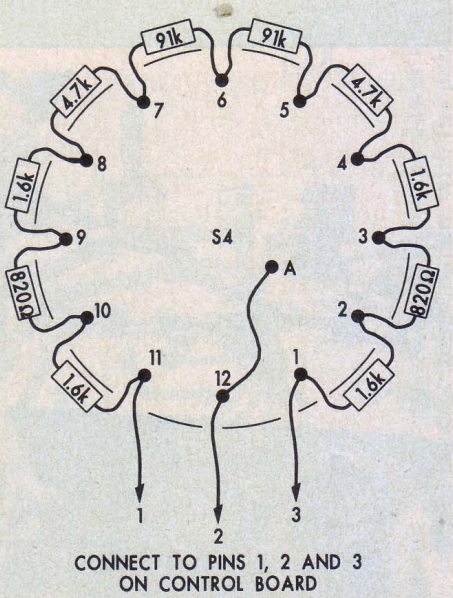


Fig.10: here's how the rotary switch is wired with the resistors to provide the balance control.

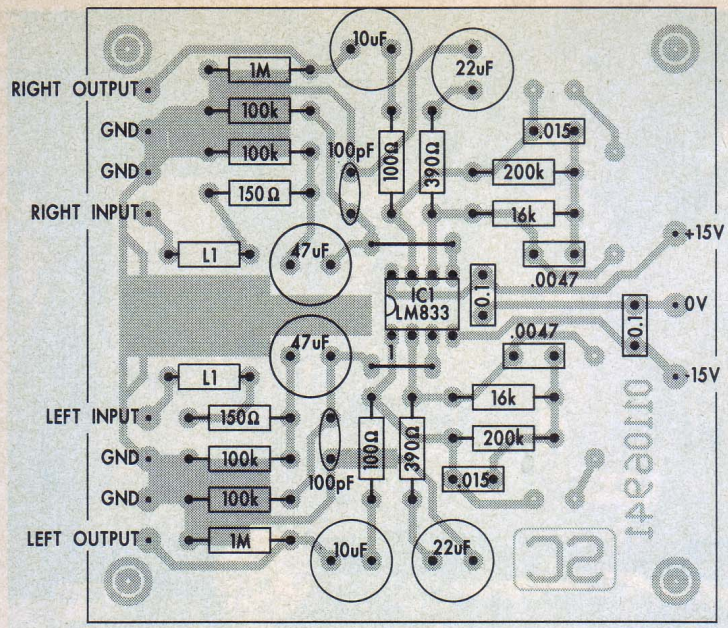


Fig.11(a): the optional RIAA preamplifier board. The large electrolytic capacitors are bipolar types & can be installed either way around.

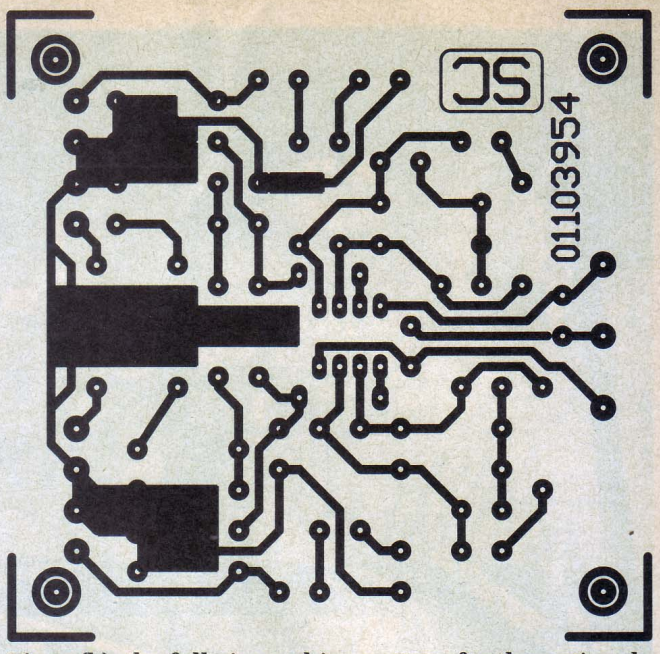


Fig.11(b): the full-size etching pattern for the optional RIAA preamplifier board. In most cases, this board will not be needed.

resistors and capacitors. Make sure that you install the electrolytic capacitors with correct polarity. This done, install the fuse clips and note that there is a trick to this task. The clips have little lugs at one end which stop the fuse from moving longitudinally. If you install the clips the wrong way around, you won't be able to fit the fuses.

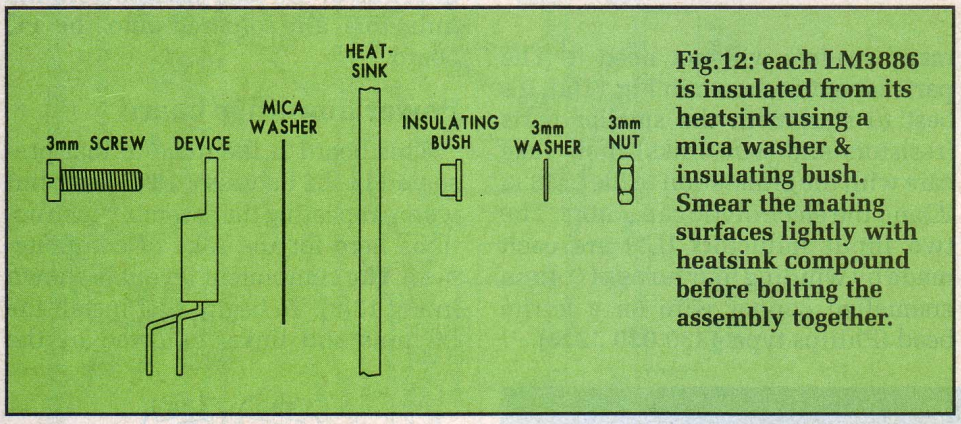
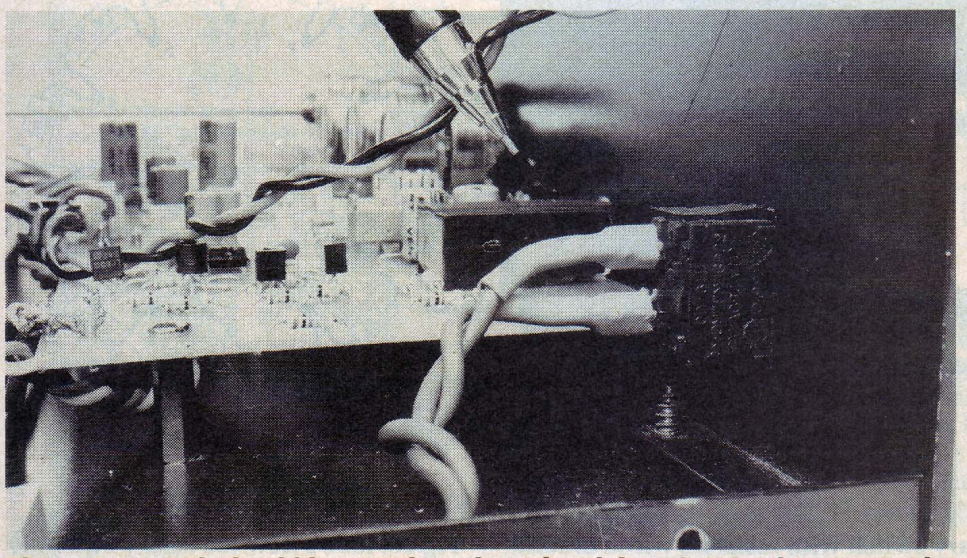


Fig.12: each LM3886 is insulated from its heatsink using a mica washer & insulating bush. Smear the mating surfaces lightly with heatsink compound before bolting the assembly together.



The mains switch should have its lugs sleeved with heatshrink tubing to avoid the possibility of electric shock.

L1, the loudspeaker filter inductor, consists of 15 turns of 0.5mm enamelled copper wire wound onto a 10Ω 1W resistor and soldered at both ends. To wind it, first scrape the enamel off the start of the copper wire and solder it to one end of the resistor. Now neatly wind 15 turns onto the resistor body, then scrape the enamel off the end of the wire and solder it to the other end of the resistor. Finally, install and solder the assembly into the PC board.

The positive and negative power supply connections to the right channel should be made with heavy duty hook-up wire (32 x 0.2mm or better) which should be twisted as shown on Fig.13(a). The 0V connections should be made via the same sort of hook-up wire but underneath the board.

Finally, you can install the power ICs. Make sure that the tabs of the devices line up precisely with the back edge of the PC board so that they can be properly secured to the heatsinks. Next, fit 15mm metal standoffs to the board and line up the heatsinks against the ICs so that the positions of the mounting screws can be marked. After drilling these holes, use standard TO-3P mounting kits to secure the ICs to the heatsinks – see Fig.12.

Use your multimeter (switched to a high "Ohms" range) to make sure that the IC mounting tabs are isolated from the heatsinks. The heatsinks we used are supplied by Altronics (Cat H-0522). To mount them into the chassis, you could use small L-shaped brackets or,

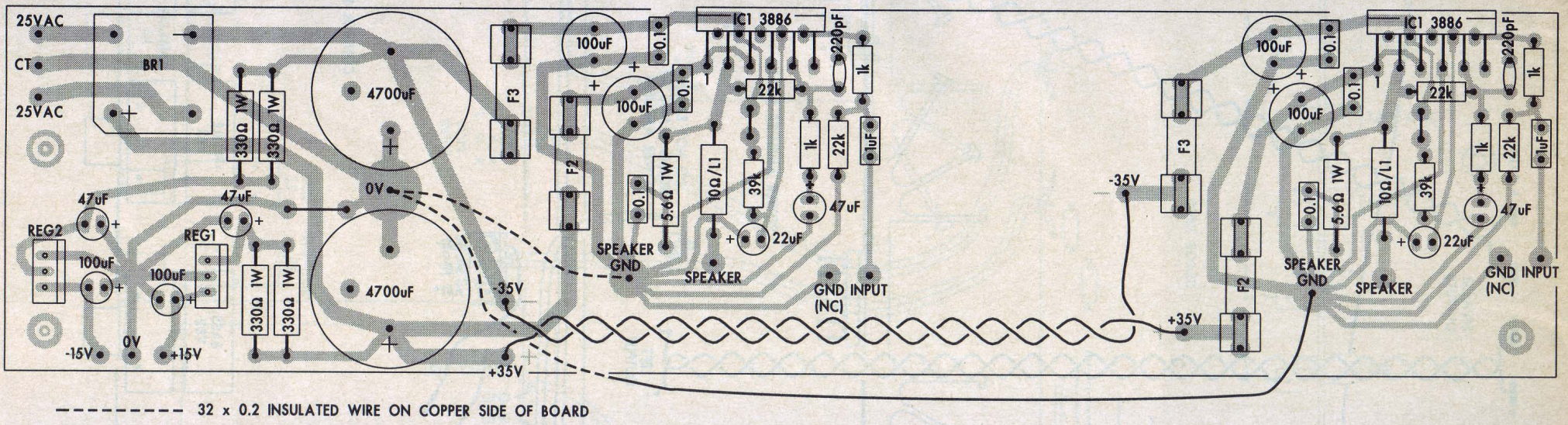


Fig.13(a): this is the parts layout on the power amplifier board. Use PC stakes to terminate external connections & note the twisted supply connections for the righthand channel. The leads shown dotted are underneath the board. The two LM3886 audio amplifier ICs must be insulated from the heatsinks, as shown in Fig.12.

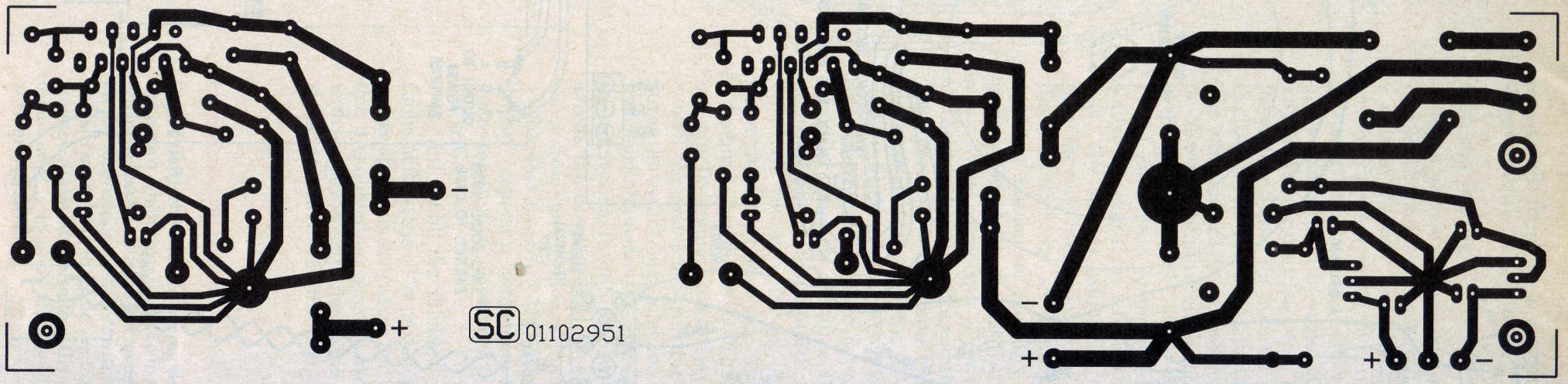
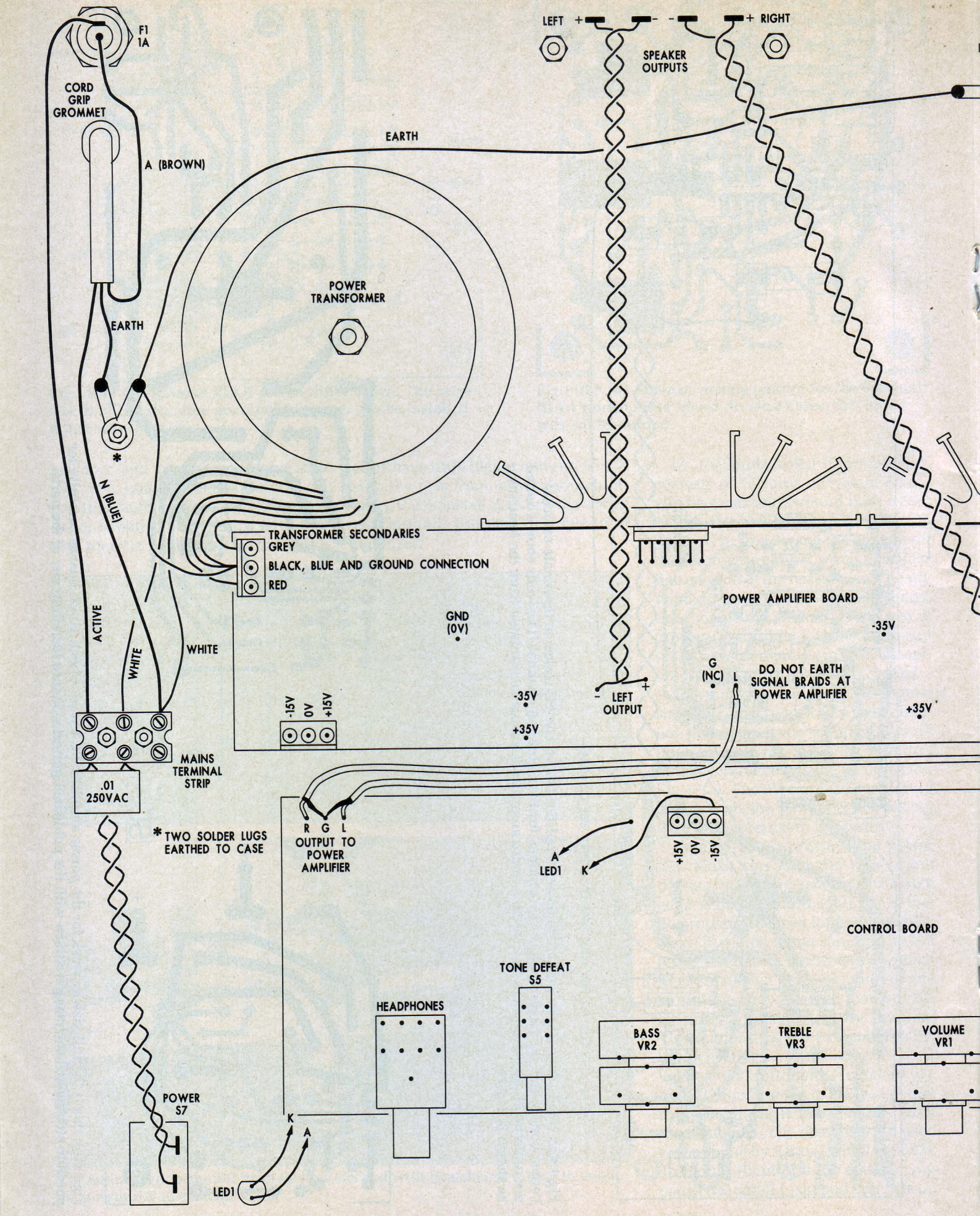


Fig.13(b): this is the full-size artwork for the power amplifier PC board. Check all PC boards carefully for possible etching defects (compare them with the published patterns) before installing any of the parts.


F1
1A
CORD
GRIP
GROMMET
A (BROWN)
EARTH
EARTH
N (BLUE)
ACTIVE
WHITE
WHITE
*
POWER
TRANSFORMER
LEFT
+
-
-
+
RIGHT
SPEAKER
OUTPUTS
TRANSFORMER SECONDARIES
GREY
BLACK, BLUE AND GROUND CONNECTION
RED
POWER AMPLIFIER BOARD
GND
(0V)
-35V
G
(NC)
L
DO NOT EARTH
SIGNAL BRAIDS AT
POWER AMPLIFIER
-15V
0V
+15V
-35V
+35V
LEFT
OUTPUT
+35V
MAINS
TERMINAL
STRIP
.01
250VAC
* TWO SOLDER LUGS
EARTHED TO CASE
R G L
OUTPUT TO
POWER
AMPLIFIER
A
LED1
K
+15V
0V
-15V
CONTROL BOARD
TONE DEFEAT
S5
HEADPHONES
BASS
VR2
TREBLE
VR3
VOLUME
VR1
POWER
S7
K
A
LED1

as we did, blind-tap holes into the edge to secure them directly.

Chassis wiring

Fig.14 shows the chassis wiring details. The mains cord enters through a hole in the rear panel and is securely clamped using a cord-grip grommet. Strip back the outer sheath of the mains cord by about 80mm. The Active (brown) lead goes to the fuseholder while the Neutral (blue) lead goes to the mains terminal block. The other side of the fuseholder goes to the mains terminal block and then to the mains switch.

The Earth lead (green/yellow) is soldered to one of the adjacent solder lugs. The second solder lug terminates the earth lead which is run along the rear panel from the binding post terminal adjacent to the RCA input sockets. Don't alter the earth wiring – you may get a hum loop if you do.

The primary leads of the transformer are connected to the mains terminal block, as shown, while the 25V secondary leads are connected to the screw terminal block on the power amplifier board. Be careful to use the correct phasing of the secondary leads, otherwise you will not get any DC output from the bridge rectifier.

Be sure to use mains-rated 250VAC cable for the connections to the power switch. We used heatshrink tubing to cover the switch lugs after the wires had been soldered on. We also sleeved the connections to the fuseholder. This avoids the possibility of an electric shock from the switch terminals.

Note that the .01µF 250VAC "anti-thump" capacitor connected at the mains terminal block must be rated at 250VAC.

Do not install the shielded signal cables at this stage. The next step is to power up each board in turn and check that it is operating correctly. We start with the power amplifier board, since it the most involved. But first, check

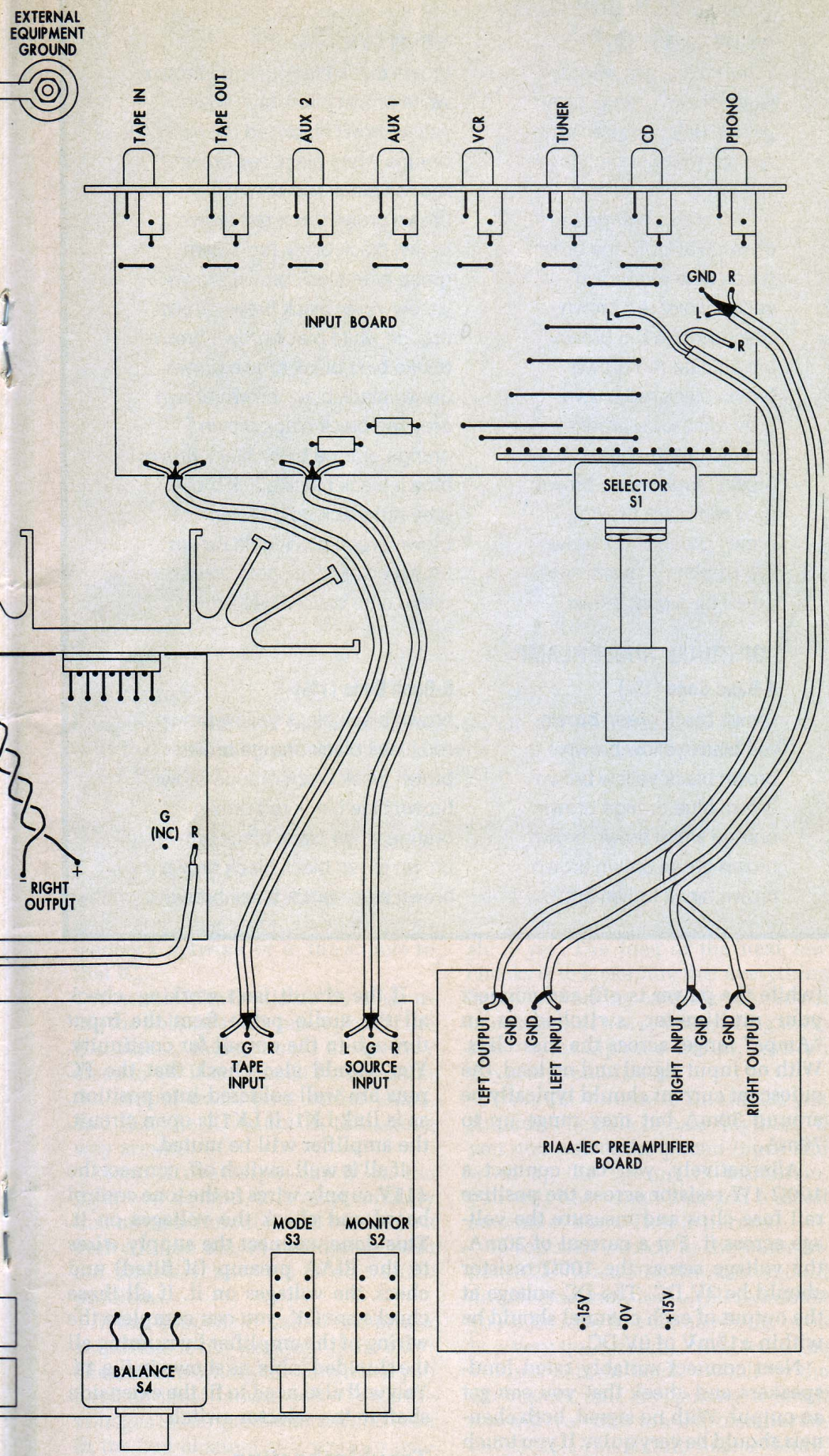


Fig.14 (left): the chassis wiring details. Take care when installing the mains wiring & sleeve all exposed terminals on the fuseholder & mains switch with heatshrink tubing to avoid accidental contact. Make sure also that the mains cord is securely clamped by the cord grip grommet.

RESISTOR COLOUR CODES

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	91kΩ	white brown orange brown	white brown black red brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	2	39kΩ	orange white orange brown	orange white black red brown
❑	12	22kΩ	red red orange brown	red red black red brown
❑	2	15kΩ	brown green orange brown	brown green black red brown
❑	4	10kΩ	brown black orange brown	brown black black red brown
❑	4	5.6kΩ	green blue red brown	green blue black brown brown
❑	8	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	3.9kΩ	orange white red brown	orange white black brown brown
❑	4	1.6kΩ	brown blue red brown	brown blue black brown brown
❑	12	1kΩ	brown black red brown	brown black black brown brown
❑	2	820Ω	grey red brown brown	grey red black black brown
❑	4	330Ω	orange orange brown brown	orange orange black black brown
❑	2	100Ω	brown black brown brown	brown black black black brown
❑	2	82Ω	grey red black brown	grey red black gold brown
❑	4	15Ω	brown green black brown	brown green black gold brown
❑	2	10Ω	brown black black brown	brown black black gold brown
❑	2	5.6Ω	green blue gold brown	green blue black silver brown

OPTIONAL RIAA PREAMP

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	1MΩ	brown black green brown	brown black black yellow brown
❑	2	200kΩ	red black yellow brown	red black black orange brown
❑	4	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	16kΩ	brown blue orange brown	brown blue black red brown
❑	2	390Ω	orange white brown brown	orange white black black brown
❑	2	150Ω	brown green brown brown	brown green black black brown
❑	2	100Ω	brown black brown brown	brown black black black brown

all your work carefully against the associated wiring diagrams of Fig.13(a) and Fig.14.

Power amplifier testing

Before checking the power amplifier board, connect a 1kΩ 0.5W resistor between the +15V and 0V rails at the 3-way terminal block (adjacent to the 3-terminal regulators). This 1kΩ resistor will draw a 15mA current from the +15V supply rail and thus ensure that the input voltage to the 7815 regulator does not exceed the ratings (ie, 35V).

Now apply power and check the supply rails. They will normally be around ±37V, depending on the value of the AC mains voltage. Now check the quiescent current in each channel. This can be done in one of two ways. The first is to remove one fuse (while the power is off) and connect your multimeter, switched to an "Amps" range, across the fuse clips. With no input signal and no load, the quiescent current should typically be around 30mA but may range up to 70mA.

Alternatively, you can connect a 100Ω 1W resistor across the positive rail fuse clips and measure the voltage across it. For a current of 30mA, the voltage across the 100Ω resistor should be 3V DC. The DC voltage at the output of each channel should be within ±15mV of 0V DC.

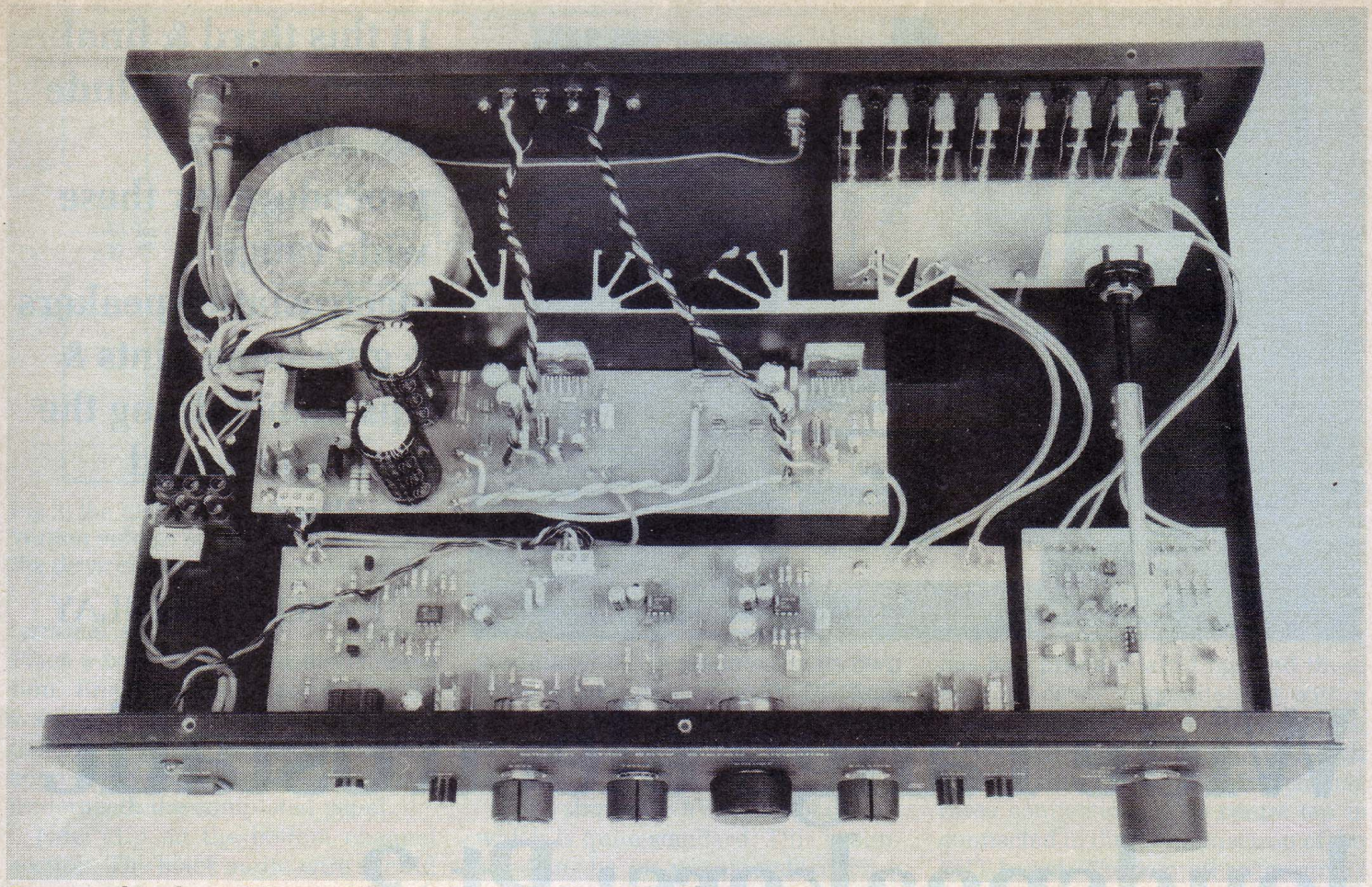
Next connect suitably rated loudspeakers and check that you can get an output. With no signal, both channels should be very quiet. If you touch the input PC pins on the PC board you should get an audible "blurt" from the relevant loudspeaker.

If the circuit isn't working, check all the audio paths from the input through to the output for continuity. You should also check that the PC pins are well soldered into position, as is link LK1. If LK1 is open circuit, the amplifier will be muted.

If all is well, switch off, connect the ±15V supply wires to the tone control board and check the voltages on it. This done, connect the supply wires to the RIAA preamp (if fitted) and check the voltages on it. If all these checks are OK, you can complete the wiring of the amplifier by running all the shielded cable, as shown in Fig.14. You will also need to fit the extension shaft to the selector switch.

Troubleshooting

If the above measurements are not OK, the most likely causes are broken



Compare this photo of the amplifier with the chassis wiring diagram of Fig.14. Note that the RIAA preamp in the righthand front corner is optional & if left out, it leaves an extra pair of high level inputs.

tracks or solder bridges between IC pins. For example, if you have the correct supply voltages on an IC but its output is close to +15V or -15V, it is most likely that there is a break in the feedback network or to the inputs to that IC.

You can follow this up by measuring the voltage at the input pins of the ICs. Again, these should all be very close to 0V. If not, check for breaks in the copper track, poor solder joints, and that the IC is not in the wrong way around.

Note: if you've put the IC in the right way around, it is most unlikely that any malfunction will be due to a faulty IC. So don't immediately rush out and buy new ICs if you strike problems.

What happens if one of the power amplifiers is not working? If the other channel is working correctly, then you have an ideal crosscheck. Check the voltages in the good channel and then in the bad channel and you can usually get a fair idea of what the problem is. It is unlikely that you will get the same fault in both channels, unless you have made the same assembly mistake in both!

Listening tests

No, we're not going to listen to music – yet. The idea of the next few checks is to make sure that everything is really working as it should. You'll need a pair of headphones. Plug them into the headphone socket, turn on the power and listen.

With the Volume at minimum you shouldn't be able to hear anything. If you now select the phono input and wind up the Volume to maximum, you will hear some hiss and a small amount of hum. That is normal.

If you now switch to the other inputs (CD, Tuner, etc), the noise should drop to extremely low levels (we doubt you'll be able to hear anything, even in a very quiet room). Now wind the Volume control back, switch to the CD inputs and try poking a small screwdriver into the left channel input socket. You should hear a "blurt" in the left channel. Now try the test for the right channel.

If you repeat this test for extreme settings of the tone controls (eg, full bass boost, full bass cut, etc) you can confirm that they are working as well. Similarly, you can check the operation of the Mono/Stereo switch and the Balance control.

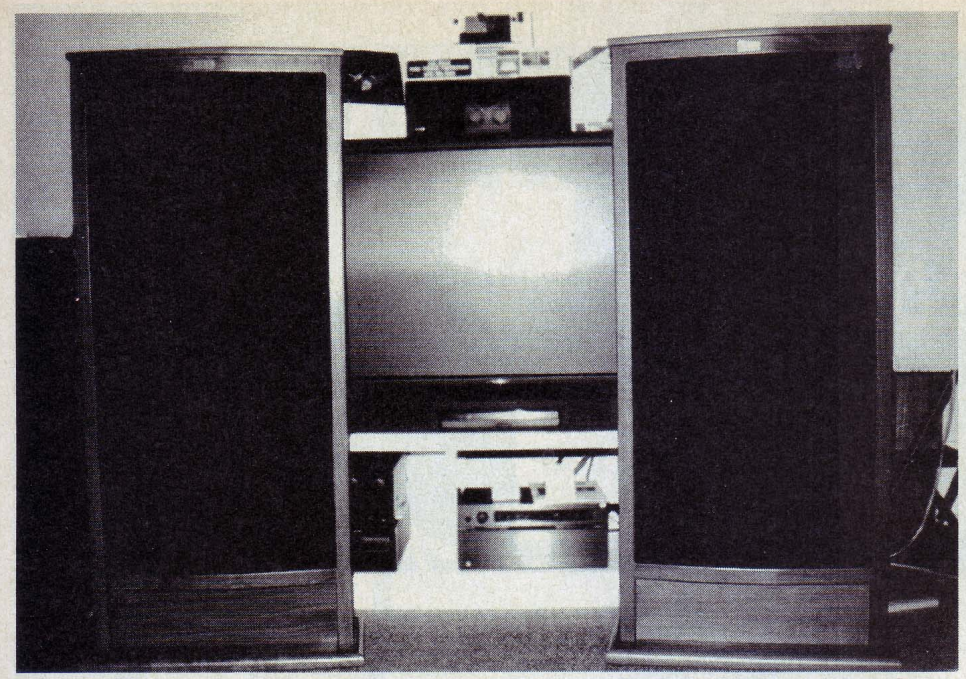
If all is well, the front panel can now be mounted but be careful – one scratch and you'll ruin the appearance of the whole project. Fit the lid to the case and the job is finished. **SC**

CAPACITOR CODES

❑	Value	IEC	EIA
❑	1µF	1u0	105
❑	.01µF	10n	103
❑	.0047µF	4n7	472
❑	220pF	220p	221
❑	100pF	100p	101
❑	33pF	33p	33

OPTIONAL RIAA PREAMP

❑	Value	IEC	EIA
❑	1µF	1u0	105
❑	.015µF	15n	153
❑	.0047µF	4n7	472
❑	100pF	100p	101



In this third & final article, we conclude the assembly procedure for these wide range electrostatic speakers & give some hints & tips on obtaining the optimum sound quality.

By ROB McKINLAY

Wide range electrostatic loudspeakers; Pt.3

Last month, we finished assembly of the half panels of which there are 12. One of each pair of half panels was fitted with the diaphragm which was tensioned and painted with a conductive coating. The next task is to assemble the pairs of half panels together. The result will be four complete bass panels and the two central treble panels.

Before assembly takes place, wires should be attached to the panels for the audio drive signal. The half panels which have the diaphragm attached should have a red wire connected to the metal grid. The matching half panels should have a black wire attached to their metal grids. The panels which have red wires attached are mounted at the front of the finished speaker system. This procedure ensures that all panels are in phase when they are connected together.

The two matching half panels are placed face to face with the diaphragm in the middle. Using the channel section supplied, clip the two halves together. A small cutout will need to be made in one long channel section to allow for exit of the EHT wire. Mark the channel section where the cutout is to be made. Drill a 10mm hole through the flange close to the channel web, then use side cutters to cut the flange out to make a 'U' shaped cutout.

Clip the channel over the two half panels starting at the EHT terminal end and push it firmly towards the centre. Ensure that the two panel halves line up with each other.

The front panel wire (the red one) is passed under the panel before the bottom channel is clipped on. It will be necessary to break out some small pieces of plastic matrix to allow easy exit. Solder the red wire to an eye terminal. Screw a brass nut onto the

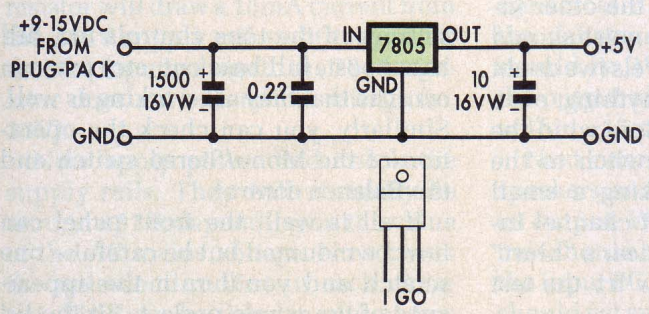
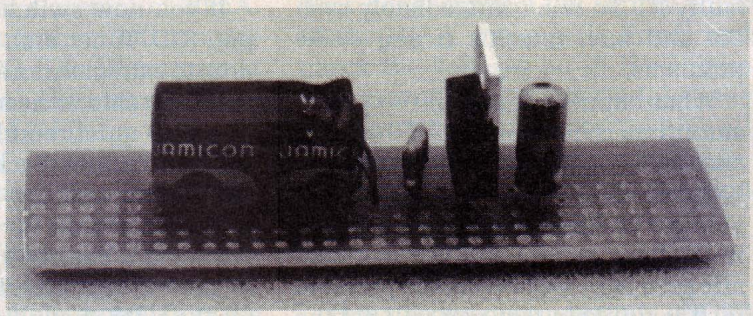


Fig.1: this circuit provides 5V DC to the EHT inverter in both electrostatic loudspeakers.



The 5V regulator is supplied pre-assembled on a piece of Veroboard but the wiring must be completed before it can be used.

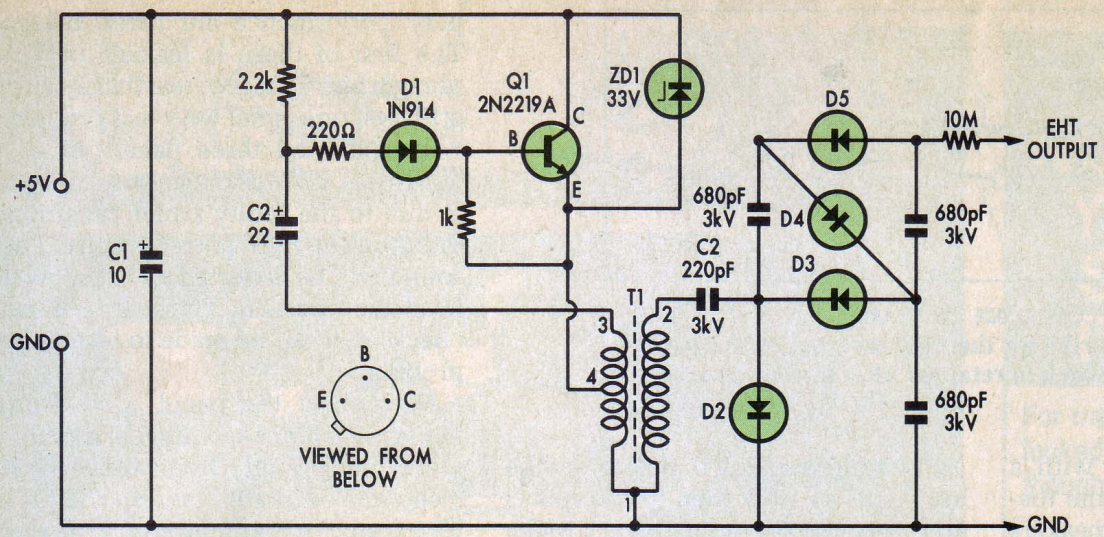


Fig.2: the EHT inverter is a 1-transistor blocking oscillator feeding a 2-stage Cockroft-Walton voltage multiplier. It generates about 3kV to provide the polarising voltage for the three electrostatic panels in each speaker.

terminal screw. Do not overtighten. Place a brass washer on the connection. Break out sufficient matrix toward the bottom of the panel, to allow the eye terminal to sit flush on the connection allowing the wire to pass underneath the completed panel.

Now clip on the bottom channel section. The black audio wire should be soldered to an eye terminal which is then bent through 90° to allow connection to the rear grid through the plastic matrix segment. Fit a 3mm brass nut onto the connection screw and tighten it but do not overtighten it.

Place a 3mm brass washer on the connection followed by the eye terminal, another washer and a brass nut. Tighten carefully.

It may be necessary to break out some small pieces of matrix to provide sufficient clearance for the terminal. This procedure is carried out on all panels.

The three panels are installed in the speaker frame with the treble panel in the centre. There are two pairs of bass panels with left hand connections and two with right. One of each is used per finished loudspeaker.

The three panels are connected in parallel; ie, all three red audio wires connected together, all three black audio wires connected together and all three EHT wires connected together.

Electronic assembly

Three electronic modules need to be put together to provide the EHT supply for the speakers. Briefly, a 9V DC plugpack feeds a 5V regulator module which is mounted in its own small plastic case. The 5V DC from the module then supplies a DC-to-EHT inverter in each loudspeaker cabinet.

Fig.1 shows the 5V regulator circuit which is quite standard. This is supplied in the kit pre-assembled on a small piece of Veroboard. It needs to be soldered and assembled into its plastic box. The two sets of output leads are wired to 3.5mm jack plugs. These plug into 3.5mm sockets on the rear of the loudspeaker cabinets.

The DC-to-EHT inverter circuit is shown in Fig.2. This is essentially a 1-transistor blocking oscillator driving a 2-stage Cockroft-Walton multiplier.

WARNING!

The voltages generated by the EHT supply and the step-up audio transformer are very high. **Never touch the output cables or terminals from the audio transformer with the amplifier running.** The high voltage output from the transformer, depending on the amplifier used, could reach 5kVAC. **This is a lethal voltage.**

The EHT supply operates at about 3kV with very low current. The high voltage capacitors used will retain a charge for some time after switch off. Always discharge the EHT cable to ground before making any connections or doing any work on the speakers.

It produces an output of close to 3kV with a 5V DC input.

The circuit is wired onto a small PC board, using the component layout shown in Fig.3. One of these boards is required for each complete electrostatic loudspeaker. Each board is mounted in its own plastic box which is itself mounted in the base of the speaker cabinet.

Final wiring

The photo of Fig.5 shows the details of the wiring. At left is the audio transformer which is driven from one channel of a stereo amplifier. The transformer has two primary windings and these are connected in parallel but with a 1.2Ω 10- watt wirewound resistor in series with each winding. The high voltage side of the transformer has three connections. The centre tap is connected to the 0V connection of the EHT board. The two other terminals are connected to the paralleled red and black wires from the three electrostatic panels. Finally, the EHT output from the inverter board is connected to the paralleled EHT wires from the three panels.

All of this high voltage wiring should be terminated in an insulated terminal block, as shown in the photo of Fig.6.

When all the wiring is complete, the back panels should be installed so that listening tests can begin.

Operating the electrostatics

The loudspeakers will take two or more hours to reach their optimum state of charge. When reached it will be maintained by the internal electronics. The plugpack power supply should be permanently connected and switched on. Its power connection is quite small (less than five watts).

Optimum loudspeaker placement is dependent on room size and shape. The following suggestions are guidelines to achieve the best performance from the ESL III's. Start with the loudspeakers about one metre from the rear wall and, in a 3.5-5 metre wide room, about half a metre from the side walls. Toe the speakers in towards the listening position.

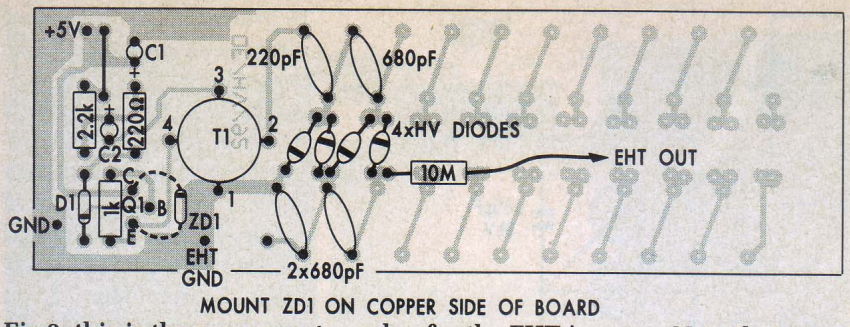


Fig.3: this is the component overlay for the EHT inverter. Note that it generates a very high voltage which is retained after switch-off (see warning panel).

Play some familiar music with a centre stage vocalist. Adjust the toe-in on one or both of the loudspeakers to make the vocalist appear centrally located. Room interference effects may cause one loudspeaker to be toed in more or less than the other. It may be necessary to toe-in the speakers until they are pointing directly at the listening position. The speakers may now be moved either closer to or away from the rear and side walls to achieve the best bass response.

The loudspeaker panel is designed as a symmetrical vertical array. This produces the best sound quality at ear level when seated. To reduce tonal variation when standing, tilting back the loudspeaker may be desirable in some rooms. The spikes supplied will provide the necessary adjustment. It is advisable to fit the spikes after the best position has been found for the speakers. This will avoid damage to floors and toes!

Use some packing to determine the best angle of lean, then fit the spikes and carry out fine adjustments. Make small adjustments to toe-in and lean; they can make big differences to the sound quality.

These loudspeakers radiate sound from the rear as well as the front. To avoid adverse effects on the imaging, it may be necessary to have some sound absorbent material such as heavy curtains on the rear wall or in the rear wall corners. You can expect to devote a few hours of "tweaking" to achieve the best results.

Like most high quality loudspeakers, the ESL III's will need running in. It will take two to three weeks of normal use before the diaphragms reach maximum compliance. You will notice better bass and improved treble after this period.

Troubleshooting

Some common problems causing poor performance are listed below. The first of these is leakage of diaphragm bias voltage to rear (black wire) grid. Just one panel with this problem will cause the three panels in one loudspeaker to perform poorly. This is due to the faulty panel causing a drain on the EHT power supply. The sound will be distorted and at a lower level than normal. There are several checks that can be made to locate the problem.

Disconnect the panel wires from the terminal blocks. Connect a multimeter on a high Ohms range (200 megohms or more) between the EHT wire from the diaphragm and the rear grid audio wire (the black one). The reading should be "open circuit".

If a finite reading is obtained, there is a conductive path between the diaphragm and its connections to the grid. To check this, split the panel into its halves and use your multimeter to check both half panels. If a finite reading is again obtained, the problem lies on the relevant half panel. The cause is likely to be some conductive material which has been caught between the foil tape or the connection point and the grid.

If no reading is obtained when the panel is disassembled, the problem will be between the diaphragm and the grid. Look for conductive material between the grid and diaphragm: hair, lint, fine wire and insects can all cause problems. Absolute cleanliness during construction pays off. During each stage of construction, vacuum any dirt or grit from the panels.

Flakes of dry conductive coating can cause problems if they get in the wrong places. Always remove your gloves away from the construction area. If the conductive coating is being applied in more than one session, wear new gloves.

Other causes can be: the centre tap of the audio transformer not connected to 0V on the EHT supply or one grid wire not making a good connection; EHT supply not working properly; the conductive coating on the diaphragm applied incorrectly (ie, patchy, too light or not making contact with the EHT foil tape); and finally, the diaphragm tension may be too low.

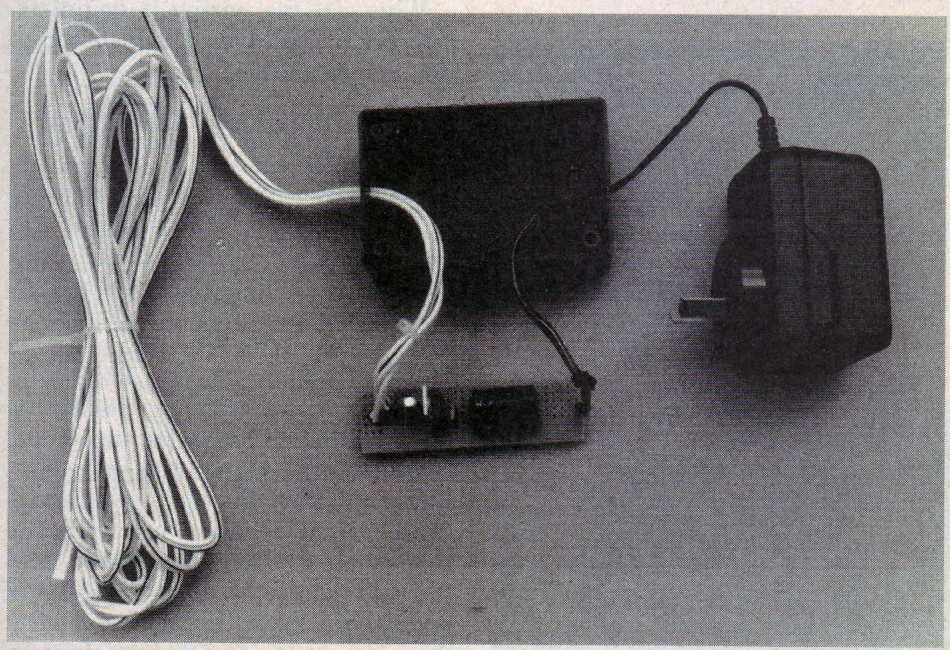


Fig.4: the finished 5V regulator is installed in a plastic box. It has two separate leads to supply the EHT inverter in each electrostatic loudspeaker.

Care of your speakers

The timber cabinets should be oiled occasionally. Grille cloths should be lightly vacuumed from time to time to

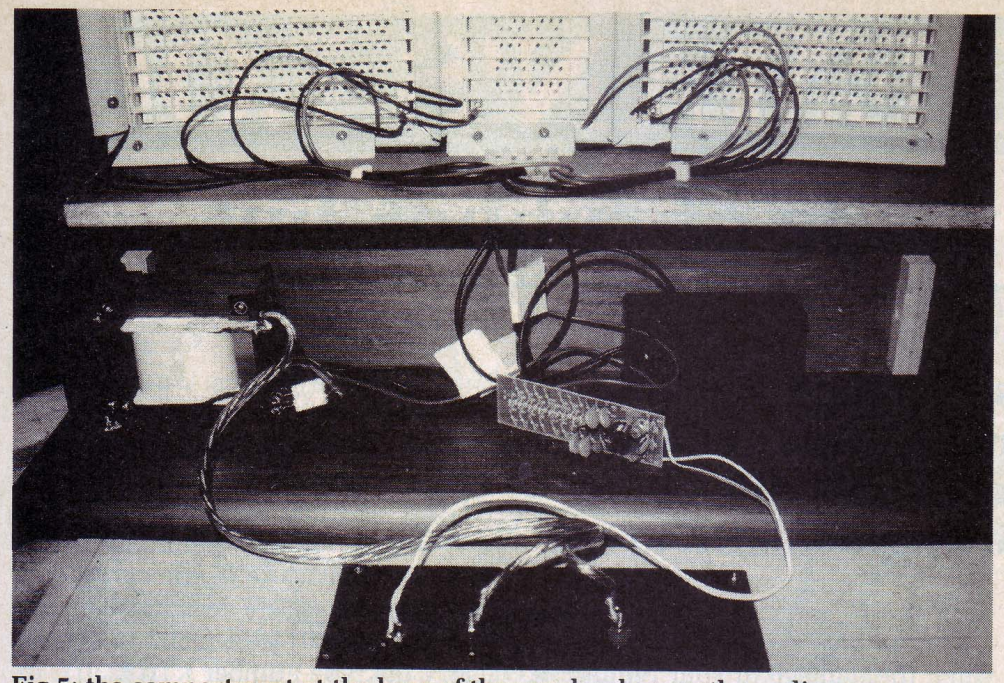


Fig.5: the compartment at the base of the speaker houses the audio step-up transformer and the EHT inverter. Note the wirewound resistors connected in series with the transformer primary windings. The inverter is normally housed in the plastic box at the rear, for safety's sake.

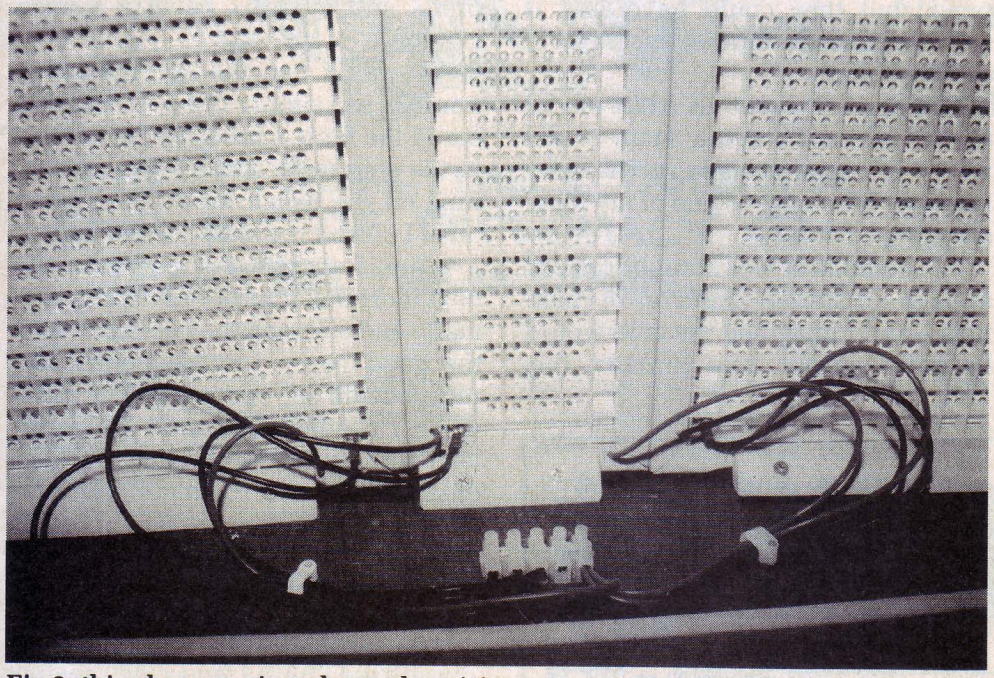


Fig.6: this close-up view shows the wiring connections to the three panels.

remove dust. Care must be taken with the front grille as the speaker diaphragm is only a few millimetres from the grille cloth. Always use the "partial suction" position on the vacuum cleaner.

Avoid exposure to direct sunlight, moisture or temperature extremes. Avoid overdriving the loudspeakers too. Power limits will be apparent by a "snap" (high voltage flashover) followed by a temporary loss of volume. Continued use under these conditions may cause damage. SC

Kit Availability

The ESL III electrostatic loudspeakers are available in kit form at $1199 a pair plus an extra $499 for the two ready-built timber enclosures. Freight, packaging and insurance will vary from state to state. For further information, contact Rob McKinlay, E. R. Audio, 119 Brookton Highway, Roleystone, WA 6111. Phone (09) 397 6212 or fax (09) 496 1546.

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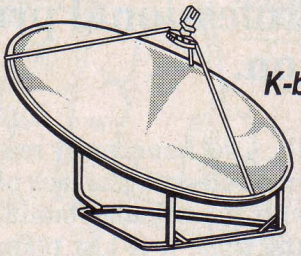

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SERVICEMAN'S LOG

Sets aren't made of rubber, but . . .

Nobody likes to have a set bounce. But let's face it; it's an occupational hazard. It happens to all of us sooner or later but it's still a blow to our professional pride &, potentially, to our reputation.

Occasionally, a set bounces by reason of our own carelessness or lack of experience with a particular brand. But most of the time, it is just plain bad luck. A second fault occurs shortly after the set is returned to the customer, probably producing similar symptoms, and the customer expects an explanation.

To be fair, most customers are reasonable but once in while one will go off his brain. And it sometimes takes fair bit of diplomacy to quieten them down.

But they are not the worst. The worst ones are the ones you don't hear about, except much later on the grapevine, when the damage to your reputation has been done.

Naturally, all those thoughts were prompted by a recent experience. In fact, none of these nasty things happened but they could have, and it served as a reminder that this threat is always there.

The story is about an AWA model C3423 colour TV set, a 34cm model which is actually made in Korea by Daewoo. It belongs to one of my long-standing customers.

His complaint was straightforward enough – distorted sound on all channels – and I imagined the cure would be quite simple. And initially, this appeared to be the case. When checked on the bench there was no doubt about the validity of the complaint; the distortion was really severe.

And, as I had expected, the cause was simple enough; failure of one of the two transistors in the audio output stage. These are designated on the circuit as Q601 and Q602 and both carry the type number KTC2230Y. In this case it was Q601. Fortunately, I had a replacement in stock but it appears that a 2SC2230 is, as far as I can determine, the same device, the KT prefix and Y suffix being a Korean version.

Anyway, I had the specified type number, so I simply fitted it. And that cured the fault. I finished the job late in the afternoon, and left the set running on the bench for an hour or so until I closed the shop for the night.

When I switched it on again the next morning, it performed quite normally and so I rang the customer with the good news. I subsequently unplugged the set and pushed it aside when I needed the bench space but later turned it back on again to demonstrate it to the customer when he called in.

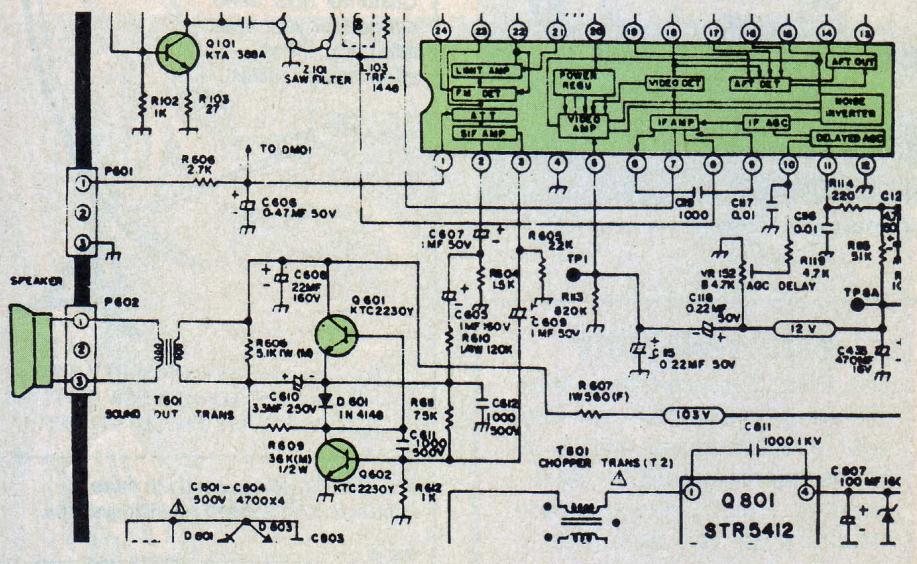


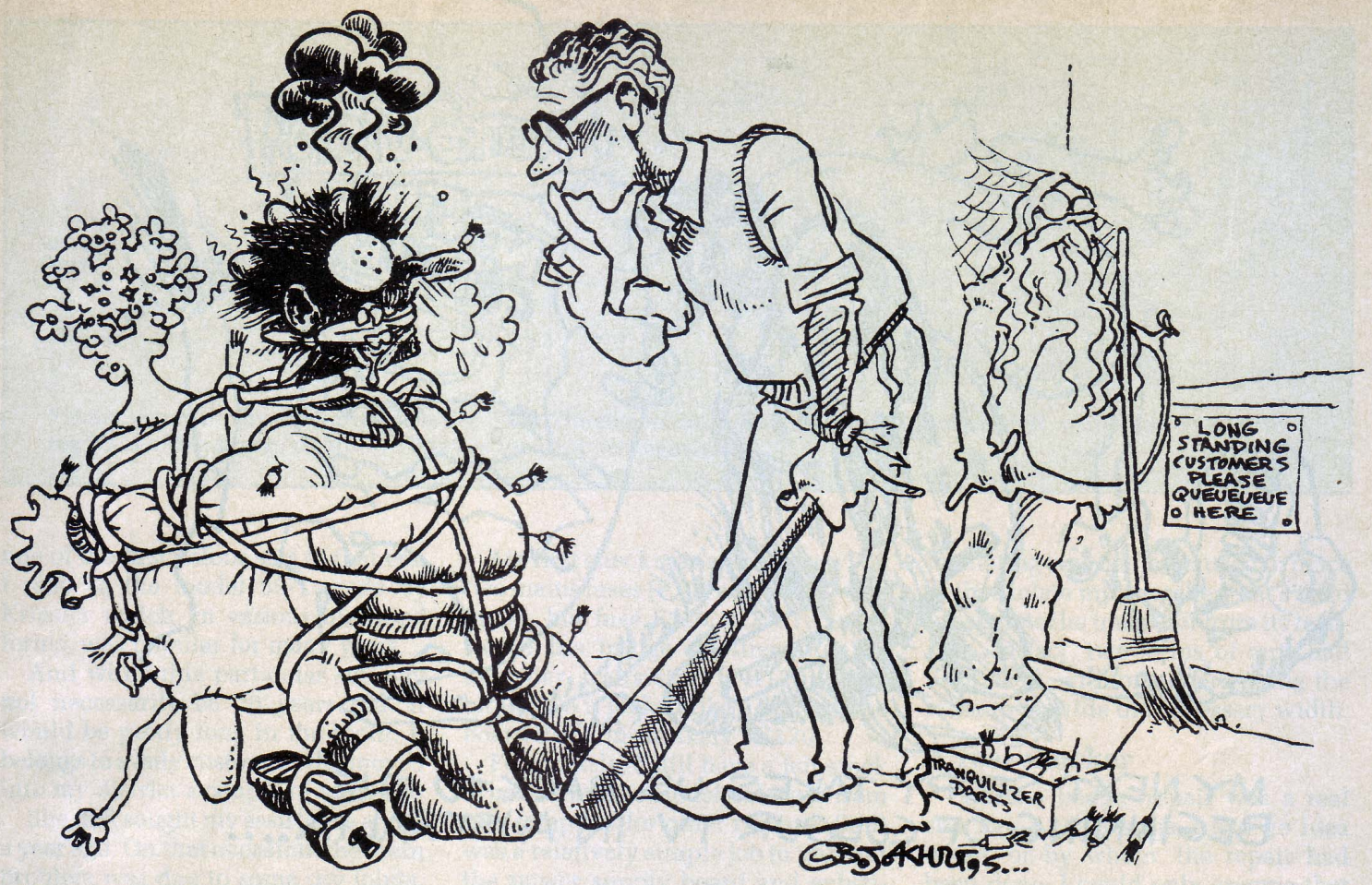
Fig.1: the audio output stage in the AWA C3423 colour TV set. The audio drive comes from pin 3 of IC101 (top) & is applied to the base of Q602 which apparently operates as a single-ended class-A stage, with Q601 as a cascode. The output appears at the junction of Q601 & Q602 & is fed to the loudspeaker via a transformer.

It's back again

So that was another job finished – or so I thought until it bounced. A couple of days later, the owner was on the phone with the bad news that the sound was still distorting. He was quite reasonable about it though, because he realised that it wasn't exactly the same fault as before.

While the original fault was obvious the moment the set was switched on, the set would now run normally for an hour or so and then would gradually begin to distort. At the end of about two hours, it was really bad. And I gathered that the owner had probably been trapped in the same way I had been, by initially using the set for relatively short periods.

So the set finished up back on the



AND IT SOMETIMES TAKES A FAIR BIT OF DIPLOMACY TO QUIETEN THEM DOWN...

bench. Initially, I let it run for about two hours, by which time it was quite intolerable. I then decided to check the audio feeding the output stage, on pin 3 of IC101. This was easy enough to do using a small audio signal tracer and it confirmed that the signal was perfectly clean at this point.

My next thought was to make some voltage checks but I didn't have much to go on. The circuit is one of those that a colleague calls "a street directory with no street names"; or, in this case, no voltages. Well, there was one, the supply rail to this stage, at 103V.

Assuming this figure was correct I reckoned there would be about 50V across each transistor. It also seemed reasonable to expect that there would be around 0.5V or 0.6V between the base and emitter of each transistor. So in spite of the circuit limitations, I was able to build up a fair picture of the likely voltages.

After allowing the set to cool down, I switched it on again and confirmed that these voltages were correct. The supply rail measured the indicated 103V rail, there was roughly 50V across each transistor, and there was about 0.5V between the base and emitter of each transistor. Having confirmed this, I let the set run until the distortion reappeared, then made another voltage check.

It was a different story this time. While the other voltages remained as before, the base-emitter voltage of Q601 had dropped significantly. I left the meter connected and let the set run. The voltage continued to drop as the distortion increased until, after about two hours, it had dropped to a mere 0.05V.

Well, that was a clue but that was all it was; I still had to find the cause. Fortunately, there is only a handful of components in this section: six resistors, six capacitors, and the two transistors.

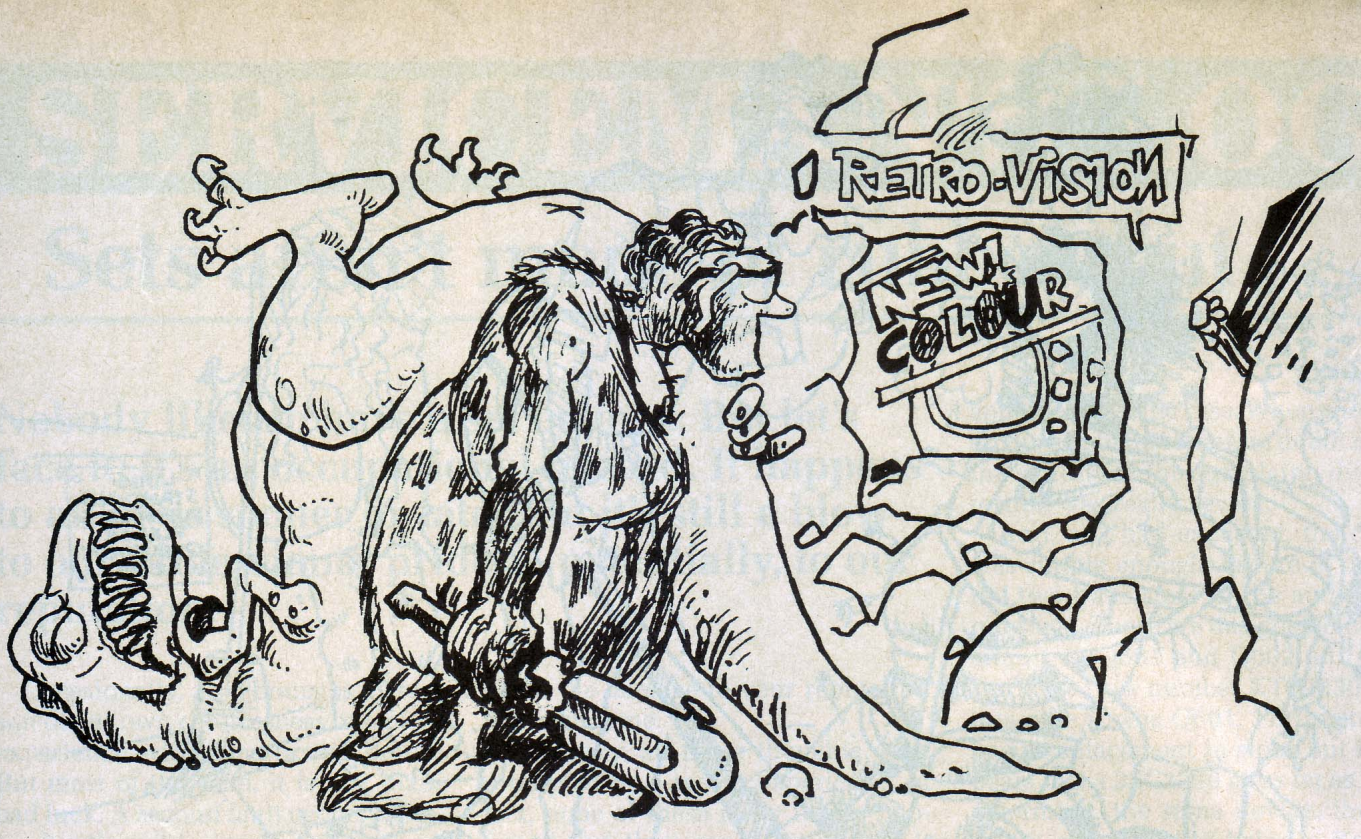
I was inclined to ignore the transistors. After all, Q601 had just been replaced and the chances of two failures in a row seemed remote. But statistics can let one down. I had more spares on hand and it was only a few minutes work to change both.

And that promptly ruled out that possibility; it made no difference. The resistors did not seem to be a high risk but were easy to check anyway. And again I drew a blank.

That seemed to leave only the capacitors – two low value plastic types and four electrolytics. Of the latter, C608 (22µF) served as a decoupler for the 103V rail. However, I couldn't relate a fault here with the observed symptoms.

All things considered, including the change in Q601's base-emitter voltage, the most likely suspect was C610, a 3.3µF coupling capacitor to the loudspeaker. It was an electrolytic, of low value, and in what appeared to be the fault area.

It was simple matter to pull it out and test it. Its capacitance measured 3.3µF as marked and there was no significant leakage. But it was just as easy to fit a new one anyway, whereupon the set produced good clean sound. More importantly, it contin-



MY NEXT STORY TAKES US BACK TO THE BEGINNING OF COLOUR TV IN AUSTRALIA....

ued to do so for the rest of the day, after which I considered the point proved.

So I'm not sure what was wrong with the capacitor. Normally, there are three likely faults in a capacitor: loss of capacitance, leakage and internal series resistance. Since it appeared to have correct capacitance and no leakage, that left only internal resistance, which is not quite so easy to measure. On the other hand, there seems little doubt that it was a temperature sensitive fault and it is sometimes difficult to duplicate the exact temperature conditions when making measurements.

So, all things considered, I'd put my money on leakage. After all, one side of it connects via the output transformer (T601) to the 103V rail and the other side to Q601's emitter. So, if it was leaky, the effect would be pretty drastic.

So it all ended happily. But it was a nasty trap and I'm not sure whether there were two quite separate faults or whether the faulty capacitor was the cause of Q601's failure in the first place. In any case, I fell into the trap. With the benefit of hindsight I should have given the set a longer soak test. But this is not always convenient and there were no symptoms to suggest that it would be advisable.

How does it work anyway?

Finally, having solved the problem, I couldn't help but wonder about that output stage configuration. It is not an uncommon arrangement and I must have looked at it many times in various makes and models of sets. And despite having replaced faulty components in these circuits, I have never bothered to think much about the arrangement.

Until now, that is. It must have been the need to service it twice in quick succession, and the need to work out voltages, which prompted me to start wondering about how it operates. The first point to note is that the two output devices are of the same type number and, therefore, of the same polarity. Compared with the popular complementary symmetry pair configurations, I find this arrangement puzzling.

And the more I look at it the more confused I become. I simply cannot grasp how the circuit works. And those colleagues I have consulted appear to be equally as confused. Some made suggestions based on other circuits with which they were familiar but nothing seemed to add up.

As already noted, the two transistors are effectively in series in the DC sense and operate from the 103V rail. The audio drive is from pin 3 of IC101 and the output is taken from the junction of the two transistors and capacitively coupled to the speaker transformer, the other side of which connects to the 103V rail.

It also appears that the output is at relatively high impedance, hence the speaker transformer. There is also a feedback network into pin 2 of IC101.

Beyond that, it is not clear how the circuit works. It would appear that Q602 operates as a single-ended class-A stage, with Q601 as a cascode. But the biasing arrangements for Q601 are something of a mystery since the base of this transistor is tied one diode drop below its emitter.

So there it is; an ultimately successful job but one which left a frustrating circuit puzzle. If anyone can throw any light on this circuit, I would be happy to pass it on to readers.

In the beginning

My next story takes us back a few years; some 20 years in fact, to the beginning of colour TV in Australia in 1975. More particularly, it involves

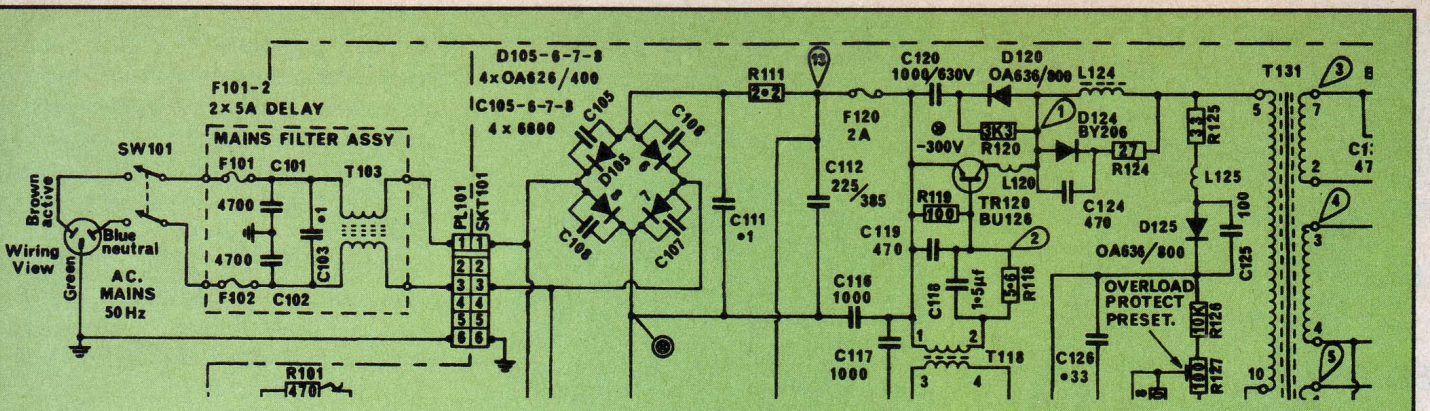


Fig.2: the power supply for the Kriesler 59-1. The two mains fuses (F101 & F102) are at left, while fuse F120 is to the right of the bridge rectifier. TR120 is the chopper transistor.

one of the first colour sets of that era. I refer to the model 59-1 made by Kriesler which, in various modified forms, was popular for many years.

And while this particular set may not necessarily be 20 years old, it would be pretty long in the tooth. It belongs to a lady customer who moved into my district a couple of years ago

She first sought my assistance about a year ago. On that occasion, the main problem was due to some dry joints, of which this set had its share. In addition, I made a routine modification to permit the set's use with a video recorder. It had been a long time since I had done this and I had to dig out the appropriate modification note to refresh my memory.

The modification involves the horizontal oscillator circuit. In greater detail, it involves modifying the time constant of the automatic frequency control (or flywheel sync system). In these early Kriesler sets and in some Philips sets of the same era, before the advent of the domestic VCR, this time constant was relatively long. This was perfectly satisfactory for the highly stable off-air TV signals but was too severe for some video recorders.

The modification is relatively simple. It involves the Line Control Unit (CU701) and pins 3, 10 & 11. Pins 3 and 10 must be connected together, while pin 11 is connected to chassis. With that done, and the dry joints repaired, the set was returned to the customer.

When it came in this time round it was completely dead and I had a gut feeling that it was power supply failure. There was no life of any kind; not even a hiccup to suggest an overload shutting down the power supply.

My first check was at the fuses. The two mains fuses (F101 and F102) were intact, but fuse F120, a 2A type between the bridge rectifier and the chopper transistor (TR120), was blown. So it looked like a fault on the board itself, most likely TR120.

Fortunately, I still have a fair stock of boards for this model, salvaged from sets scrapped for other reasons. So it was a relatively simple job to pull out the power supply board and substitute a known good one. This would at least confirm my suspicion and clear the rest of the set.

And it did; the set came to life immediately and put up quite a creditable performance, considering its age. Even the picture tube looked as though it was good for a few more years.

OK, so the fault was on the power supply board. If it was as simple as I suspected, it would be well worthwhile repairing. Naturally, I went straight to the chopper transistor pins, on the underside of the board. And a quick check with the meter confirmed my suspicion – it was shot, base to emitter.

I unscrewed the mounting nuts, then turned the board over to pull the transistor clear. And this was the first hint of something unusual. One glance was enough to indicate that there had been "a certain amount of mucking about going on", as one of my colleagues often puts it. Sticking out from under the transistor were some pieces of black insulating tape as used by electricians.

It was now clear that TR120 had been replaced on a previous occasion. This was no surprise – faults of this kind are common enough in all sets. But the nature of the repair was. The insulating tape had been used in place of the isolate mica washer that's used to separate the transistor from its heatsink. In fact, two strips of tape had been used, with one overlapping the other to provide the necessary width.

A real shocker

Such a bodgie repair was a real shocker. At that stage, I had no idea when, or by whom, the repair had been done. I could only assume that someone had been caught out in the field without a washer and had taken this way out to do a quick repair and avoid a return visit.

Well, that would be an explanation, if not an excuse. But it is a pretty rough approach. For one thing, as we all know, insulation tape degenerates with time, particularly in a heated situation such as this.

And, in any case, it would provide very poor thermal conduction compared to a standard mica washer. The standard washer is made as thin as possible, consistent with adequate electrical insulation, in order to provide maximum thermal conductivity, usually aided by a heatsink compound.

Insulation tape is thicker and, in this case, there was a double thickness of tape where the two strips overlapped in the middle of the transistor between the two pins. In fact, I took a few minutes off to check these thicknesses with a micrometer.

A typical washer is of the order of .005in, while a single thickness of this tape was .008in, making a double thickness of .016in (pardon the imperial measurements; my micrometer goes way back.) So the poor old transistor must have been running much

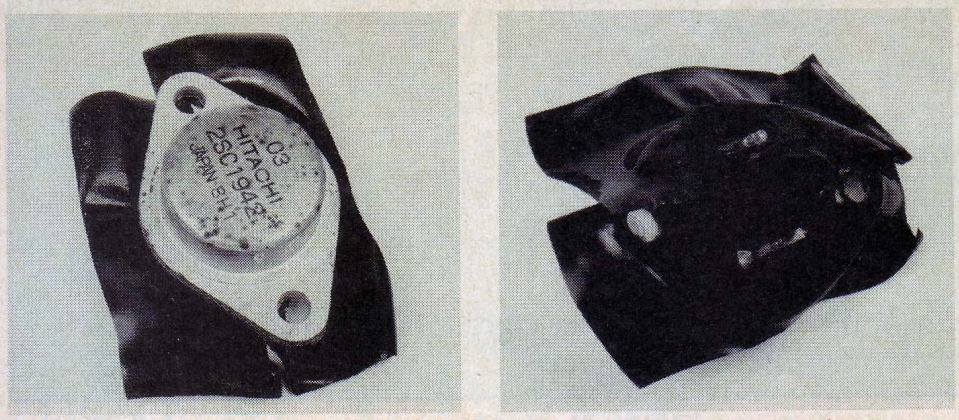


Fig.3: a previous "serviceman" had isolated the chopper transistor using two pieces of electrical tape instead of a proper mica washer. It's a wonder it lasted as long as it did.

hotter than it should have been since the repair was made.

Naturally, I fitted a new TR120, complete with the correct washer, whereupon the set came back to life. There had been no other side effects from the failure.

But the bodgie repair raises the question as to why this transistor failed. Maybe it was due to fail anyway but there are two far more likely possibilities. One was that there had been an electrical breakdown between the transistor case and the heatsink, as the tape did not fit too snugly around the mounting bolts. Alternatively, the lack of adequate heatsinking may have finally taken its toll.

Who did it?

But regardless of the reason, that is no way to repair a TV set. I was curious as to how it had happened so, when I rang the lady to advise her that the job was finished, I raised the matter of the previous service – after all, it did involve the same component.

In fact, she was most helpful. It transpired that, before moving into my area, the set had been covered by a service contract with a large service organisation. And when she came in to collect the set, she brought all the relevant documents with her, including the job sheet for the service in question.

And this produced another surprise. There was no suggestion of an emergency repair in the house, as I had envisaged. According to the dockets, it had been taken to the company's workshop and the job done there. So how on earth could such a bodgie job be justified?

The documents also pinpointed when the job had been done, which was about six years previously. So it had lasted rather longer than I would have expected. But that's no excuse.

What firm was it? No, I'm not saying. I've seen and heard only one side of the story. There could be an explanation which completely absolves them, so we'll let it rest there. But it was a nasty act on somebody's part.

The intermittent VCR

And finally, here is a story from a reader, J. S. of Portarlington, Victoria. Here's how he tells it:

After reading the Serviceman's Log in the August issue of SILICON CHIP about the NV-370 and NV-600 VCRs, it rekindled my memory of an NV-470 I had fixed two months earlier.

This was one of those intermittent faults. Don't you just love those? This particular problem seemed to involve the power switch. At times, one could keep pressing it and get no response whatsoever. Even shaking the whole unit, or prodding the board around the power section, would not revive it.

And then, for no apparent reason, it would come good and remain so. Once again I repeated the shake and prod tests, with no result.

I waited for it to reappear of its own volition. When it did, I took the covers off and removed and replaced a couple of the 3-pin wire connectors (PJ1003 & P1002) on the power section of the board. And bingo, the problem vanished. A dirty connector? I subjected the unit to another shaking and prodding test and, as it did not fail again, I more or less accepted that this could have been the cause of the problem. At that time, I did not have a circuit diagram with which to check the layout.

But not being 100% satisfied that the problem was solved, I kept it for further observation. Sure enough, some eight days later it happened again. It was time to get serious and get a copy of the circuit. Thus equipped, I realised that at least one of the connectors I had changed, PJ1003, had little to do with the power supply circuit.

On closer examination of the copper side of the board, in the power supply region, I noticed some discoloration, apparently due to overheating, around transistor Q1001 (2SD-1275), the voltage regulator for the 12.7V rail. At the same time, I had my finger on Q1001's heatsink and as I applied pressure, it sank towards the board.

My interest aroused, I wiggled it and watched it from the solder side. The unit was plugged in at the time, and I noticed arcs being emitted from Q1001's collector and its copper track. Sure enough, the fault could be induced and corrected by wriggling Q1001's heatsink.

Closer examination of the copper tracks around Q1001 revealed that the collector track had broken due to the size of the heatsink. This was attached directly to the transistor body, without any anchoring pins into the board. Q1001's base and emitter pads were also beginning to lift off the board.

I soldered a substantial piece of tinned copper wire to each lead of Q1001 and along their corresponding copper tracks, which gave the transistor and its hefty heatsink a solid base. Hopefully, this will solve the problem for the life of the unit.

This fault clearly illustrates that one should always start any diagnosis with a thorough visual inspection. The telltale signs could be very time saving, as in this case, especially as I was looking around and at the fault right from the start.

Thank you J. S. for an interesting story. Your point about a thorough visual inspection is well taken. I've been telling myself that for years but I still get caught. **SC**

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INFORMATION OVERLOAD!!!

40 CHARACTER / 2 LINE, 5 X 7 DOT MATRIX LCD DISPLAY BARGAIN!
Yes, another Jaycar scoop purchase where you reap the benefit. This time its a quality, Seiko brand (Japanese made) 2 line readout module similar to the "dispatcher" panels now seen in taxi-cabs.
The panel has a built-in character generator ROM/RAM, 192 (yes 192!) character types, single +5V supply, 80 x 8 bit display area and electroluminescent display backlight illumination for night viewing! The display is so intelligent it only requires drive from 4 or 8 bit micros. Individual character height is a healthy 5h x 3w(mm) approx. Easy viewing from up to two metres away - wide angle OK.

NEW

Learn display technology while you have fun!
Each module comes with an easy to read 32 page instruction manual. This gives full technical information on the unit, including interfacing and drive data. You can program the display to readout in virtually any symbol within the 5 x 7 (+ cursor) format. (The character generator ROM generates 192 standard fonts, the character generator RAM gives you this flexibility).
You would expect to pay $60 plus in large quantities for such a piece of technology, so why are we so excited about this?
There is a downside. The displays are not brand new. They have been carefully removed from recent equipment by skilled technicians and are totally undamaged. The reason why they were removed was to make way for even larger information displays. There is nothing wrong with the displays that we offer you - they are simply the victim of relentless technology. They have not even done a lot of work. We guarantee that each unit is fully operational and within specs at the time of sale.
Yes, and there is more!
The display will work fine in daylight or in an illuminated indoor situation. They really come into their own, however, when they are lit up at night by the Electroluminescent Lamp (EL) panels built into the units! This makes them ideal for mobile use!
In order to do this, you need a DC to AC 115V 400Hz inverter/generator. Boy that sure sounds expensive! Well, yes it is, but not for you!!
Included in the cost of the panel, and the massive technical manual we will provide AT NO EXTRA COST, is a US made EL panel driver inverter! They work at the same +5V supply as the panel! Sure, they are used also but they are in brand new condition as well. Naturally we provide full technical info on this part as well. (It only has 3 connections; "input", "output", "common earth").
Let's summarize what you get: •80 characters (2 line x 40 character) LCD wide angle LCD display with built-in surface mount electronics and stainless steel bezel. Standard 0.1" PCB launcher connection (new condition, but removed from equipment). •massive data manual which includes info on our EL driver module (don't ask for any more info - there isn't any)! New stock. •32 x 23 x 21mm, US made EL panel driver module. (new condition, but removed from equipment).

You would expect to pay over $80 plus for this in OEM quantities, heaven knows one-off if you could get them to sell you one! In typical fashion, however JAYCAR has screwed the source down so that their loss is your gain!!! You can have a great time playing with one of these at the fantastically low price of $19.95.
As usual with things like this, quantities are strictly limited so get in early! They do work well but if you need a spare, buy 2 now!! They won't be around next year. We repeat, the goods are not new but they may as well be. They have suffered no deterioration in service except for a bit of solder on some of the leads.

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These are in our catalogue at $17.50. We have found that many of these have a problem with them where the LED won't light, or one of the charging bays doesn't work. So, we are offering these at below cost. You can now buy 2 for less than the price of one, and charge 6 batteries at a time!

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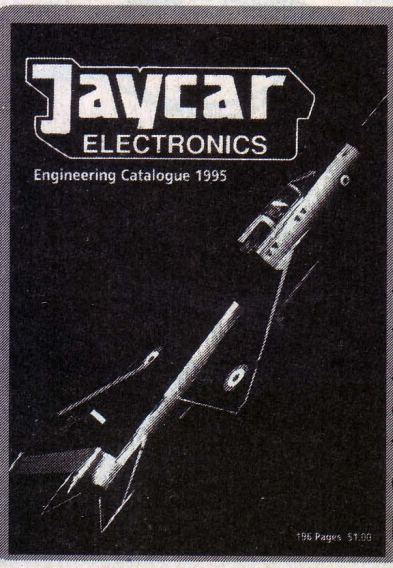

NEW CATALOGUE LAST MONTH

The Jaycar 1995 196 page catalogue was released last month. It includes hunderds of new and interesting products. If you haven't got your copy yet call into any Jaycar store or dealer and pick one up for $1, or send $2 to Jaycar, PO Box 185 Concord. 2137, and we'll post you one.

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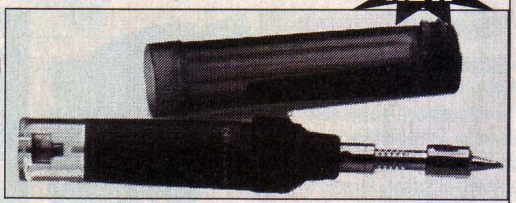
NEW

The new one is smaller than our previous model and has been further refined. See our catalogue for full details.



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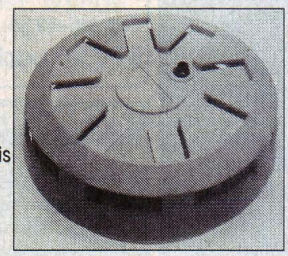

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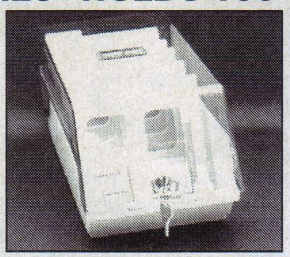

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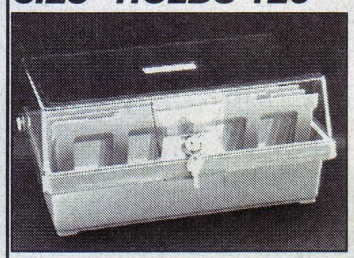

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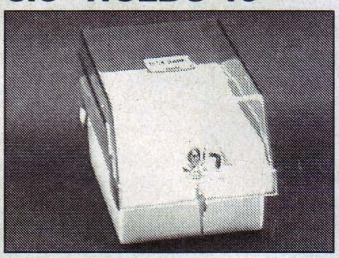

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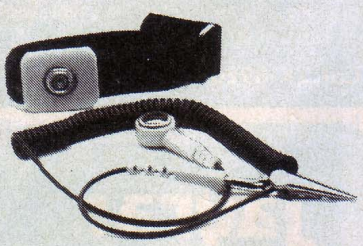

Use when static electricity is a problem when soldering, changing ICs and installing expansion cards in computers etc. Static charges can destroy ICs instantly. Consists of adjustable velcro wrist strap, coiled lead and banana plug/alligator clip. Expanded lead length about 1.8 metres.

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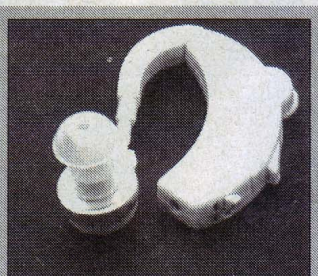

Majic Ear is an amazing aid to hearing that sits comfortably behind your ear and magnifies sound with superb clarity. If you have trouble hearing the TV, listening to the radio etc than Majic Ear will help. With the aid of the latest micro electronics technology in Majic Ear your hearing problems can be reduced, and you won't have to pay $1,000 or more.

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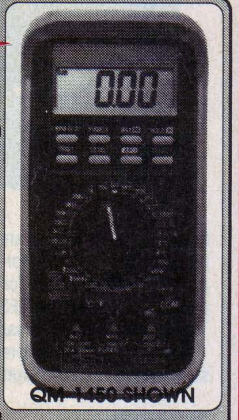
New Automotive Meters

NEW



These professional quality automotive meters have been designed for todays complex automotive electronic system diagnositc and troubleshooting. The meters are built inside a gasket sealed heavy duty casing which keeps out grease, oil, dirt and moisture to maintain superb accuracy and reliability. The case is made of high impact thick wall fire retarded material and has a sealed battery compartment separate to the PC Board.

•The QM-1440's measuring functions include DC Voltage, DC current, Resistance, Duty Cycle, RPM, Dwell Angle, Diode Tester, Continuity Tester and Contact Tester.

•The QM-1450's measuring functions include: DC voltage, AC Voltage, DC current, AC current, Resistance, Frequency, Duty Cycle, RPM, Dwell Angle, Temperature, MS Fuel Injection Detector for Port Fuel Injector (PFI) and Throttle Body Injector (TBI), Diode Tester, Continuity Tester, Fault Code Detector, Contact Tester, Alternator Tester. Push Button functions include 2 stroke and DIS or 4 stroke engine RPM selection, convenient Internal Fuse Test, absolute maximum data capture, data hold, positive or negative trigger slope select, High or Low Trigger level select, disable or enable auto coded secondary functions selection.

QM-1450 SHOWN

For full details see our 1995 catalogue.

Cat. QM-1440 **$159.00**

Cat. QM-1450 **$239.00**

Inductive RPM pickup to suit
Cat. QM-1455 **$32.95**

Indoor TV Antenna Amplifier Splitter

NEW

This handy amp is designed for indoor use. The antenna lead is plugged into the amplifier, and there is two outputs to two TVs. Ideal for low reception areas, or installations where several TVs are being used from a single antenna. Our tests show that this unit, even though its cheaper, works better than previous models sold.
The gain is 36dB, UHF/VHF/FM, noise figure below 3dB. Size: 150 x 80 x 50mm. Power requirement - 12VDC 120mA. Use an mains adaptor or Cat MP-3002 $10.95

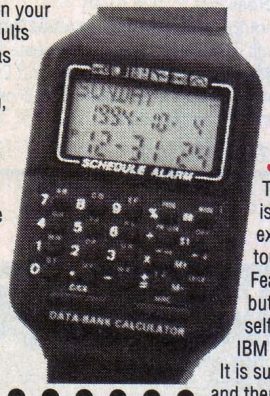
Cat. LT-3286 **$27.95**

Tantalum Capacitor Pack

This pack contains approximately 100 Tantalum capacitors in both Tag style and Mil Spec RT style. There is about 60 tags and 40 RT types in each pack.
To make up this pack we have used many different values, but there is small quantities of each value. So, generally each pack will be different. For example each pack will contain 4 pcs from this range of 8. Each pack will probably have different ones: 0.1/35V, 0.15/35V, 0.22/35V, 0.47/50V, 3.9/350V, 68/16V, 0.27/35V.
Tag values range from 0.1uf 35V up to 330uf 6V. Other values also supplied include: 150uf 6V, 10uf 35V, 22uf 50V, 47uf 25V, 100uf 16V. We can't guarantee any one pack will include all or some of these however. RT Mil Spec values range from 0.1 50V up to 180uf 10V.
Total different values used to make up this pack is 108. Tantalums are very expensive. Tags range from 60¢ to $2.50 each and Mil Spec RTs can cost well over $5.00 each.
Even at the lowest price of 60¢, values this pack at $60. We would put the value more like $100.
Limited quantity available.

Cat. RZ-6690 **$15.00**

Databank Calculator Watch



Store your 50 most used phone numbers on your watch!! Full instructions supplied - even adults can use it! This amazing database watch has the following features
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Schedule Alarm Enter your reminder note and the time/day you wish to be reminded. Ideal for memory jogging. For further details see our new 1995 catalogue

Cat. XC-0260 **$19.95**

Computer Joystick

This ergonomic designed joystick is extremely robust and can handle extreme treatment from the toughest of games players.
Features include: •2 sure action fire buttons •a positive response and self centering stick •compatible with IBM PC, 286, 386 and 486 machines. It is supplied with cable and D15 plug and there is also X and Y calibration controls if required. Size - base: 112(W) x 120(Dia)mm. Total height 200mm.

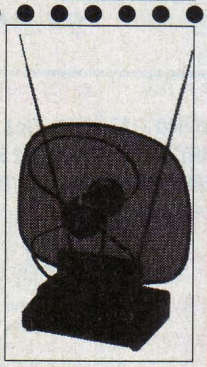
Cat. XC-5156 **$24.95**

Indoor UHF/VHF/FM TV Antenna

The ultimate indoor antenna - built-in mixer for UHF/VHF/FM - wide frequency band from 40MHz to 890MHz. Directional fine tuning possible with variable direction inner reflector - easy to mount - 75Ω impedance with coaxial cable and plug.

Cat. LT-3130 **$19.95**

Indoor UHF/VHF/FM Antenna with Built In Amplifier



This antenna has a built in amplifier. Its ideal for low signal areas, or can be used as an amp for an external antenna as well. It has adjustable gain, and has two LEDs to advise which antenna is used. It requires a 12VDC at 100mA plug pack for operation. Use an existing one or use Cat MP-3002 $10.95.
Specifications:
•Bands: UHF/VHF/FM •Channels: 5 to 69
•Gain UHF: 28dB •Gain VHF: 24dB
•Impedance: 75 ohm •Power: 12VDC 100ma

Cat. LT-3132 **$34.95**

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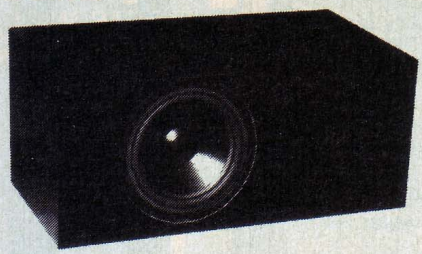
JV80 8" Subwoofer Kit

NEW



Refer: Electronics Australia April 1995.
Amazing bass from such a small enclosure! This subwoofer uses one of Vifas new long stroke, low reflection magnesium basket woofers. The driver has an impedance of 6 ohms, so could also be used in a car situation. The power handling is very large, for such a small driver being 150 watts nominal (RMS) a long term max rating of 300 watts (on for one minute, pause for two minutes) and a short term max power of 500 watts (on for one second, pause for one minute). We also recommend you use a polyswitch RXE300 Cat RN3472 $10.95.
The enclosure is very small with a volume of 35 litres and only 600 x 270 x 300(D)mm. The cabinet is supplied prebuilt and is made from MDF in blackwood veneer. Grill is supplied with speaker cloth mounted.

SPEAKER
Cat. CW-2115 **$199.50 ea**

POLYSWITCH SPEAKER PROTECTOR
Cat. RN-3472 **$10.95 ea**

CABINET - PRE BUILT
Cat. CS-2540 **$139.00 ea**

TOTAL: $349.45 ea

D19 Tweeter

D19 is a 19mm dome tweeter with polymer high loss diaphragm. Very smooth and versatile, and offers excellent dispersion. Ferrofluid cooled voice coil ensure high power handling and perfect damping. Suitable for any 2, 3 and 4 way systems with power handling up to 100 WRMS.
Specifications:
•System power: 100wrms •Freq range: 3hz to 20kHz •Resonance: 1700Hz •Voice coil diameter: 19mm •Sensitiviy: 89dB 1w/m •Nom impedance: 8 ohm •Suggested crossover point: 5kHz

Cat. CT-2019 **$39.50**

4 Zone Digital Home Alarm With Dialler

The alarm is made by DSC in Canada, and features an Austel approved digital telephone dialler which has the ability to ring a friend, neighbour or a security monitoring company when triggered.
For full specifications and features see our new 1995 catalogue on page 69.

Cat. LA-5350 **$279.00**

•Backup battery and mains adaptor extra.

Shielded Speakers

Shielded speakers are designed to be used near televisions and computer monitors. Normal speakers effect the picture by distorting it due to the speakers magnetic field. Shielded speakers have a second magnet mounted on the back of the first magnet. This extra magnet does not effect the performance at all, and these speakers can be used in place of a non shielded tweeter without compromise. The cost difference of the extra magnet is minimal.

Shielded Dome Tweeter

NEW

This tweeter represents very good value for money it has a very good high frequency response extending right up to 20000hz .It features a light dome made of mylar and a frequency dispersion plug. It makes a perfect companion to our 120mm magnetically shielded speaker.
SPECIFICATIONS. •System power: 80 watts •Freq. Range: 3000 - 20000 hz •Resonance: 2350 hz •Sensitivity: 94db 1W/1M •Nom Imp: 8 ohms. •Suggested crossover point 5000 hz.

Cat. CT-2006 $16.95

5" Shielded Woofer

NEW

This quality driver has a black poly cone with a rubber surround. Applications would include replacement in large televisions, or as the basis of a low cost, good sounding, centre channel speaker. This speaker also has two 8 ohm voice coils which means impedance is very versatile best performance is at 16 ohms.

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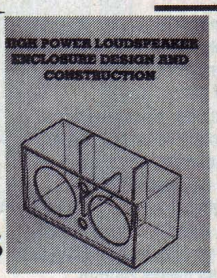
You build the cabinet, and the speakers and crossover are only $105.35 for the 4 units. See catalogue for full specifications.

Cat. CW-2102 $39.95

High Power Loudspeaker Enclosure Design And Construction Book

NEW

The designs in this book are applicable for all types of high power sound reinforcement and musical instrument amplification systems. The information given will enable sound systems from fifty to several thousand watts to be correctly made and installed. The first part of the book is a comprehensive technical section covering much of the theory of selecting and matching loudspeaker components, electrical connections, crossover design and use, with details of materials and methods of construction. 30 designs shown in an easy to follow constructional drawings with technical specification data. The recommended drivers are English. Softcover - 165 pages - 292 x 207mm

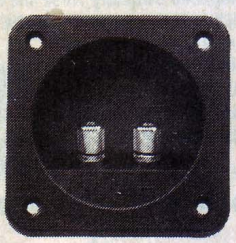


Cat. BC-1166 **$24.95**

Gold Banana/Screw Terminals On A Plate

Same terminals as the PT-3008, except that they are mounted on a plate. Top quality speaker terminal. Plate size 99 x 99mm. Hole cutout is round - diameter 76mm.

NEW



Cat. PT-3012 **$7.95**

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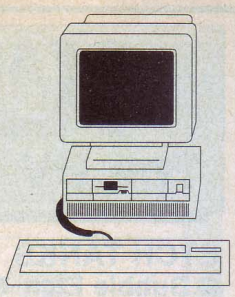
COMPUTER BITS

BY GREG SWAIN



Prune & tune your hard disc for optimum performance

Is your hard disc bulging at the seams? A good clean out might be all that's need to restore performance & free up lots of valuable space.

It wasn't too long ago that a 20Mb hard disc was considered more than adequate. Why would you need anything bigger? We all know the answer to that, of course. With the advent of Windows, programs grew in size, with some now requiring up to 30Mb of disc space just to install them.

Now, you would be foolish to contemplate purchasing a computer with a hard disc capacity of less than 240Mb. And if you intend running a lot of graphics-intensive programs, then a 540Mb or larger hard disc is the minimum requirement (along with a high-end processor and lots of RAM).

Even so, it's all too easy to fill up a large hard disc. But before going out and investing in another drive, take a good hard look at your files. It's just possible that, with some simple housekeeping, you can free up great chunks of hard disc space and save those hard earned dollars.

Here then are five simple steps to freeing up hard disc space and tuning it for best performance. Some of them are obvious but you would be surprised just how many people ignore the obvious.

Step 1: Delete Old Files

Work files that are no longer wanted simply tie up valuable disc space. Delete them using the Windows File Manager. This job can often be made easier if you first sort your files by type or by date. To do this, click on View in File Manager, then select the wanted option from the drop-down menu box.

If you are in doubt about deleting a file, create a "garbage" directory (ie, C:\GARBAGE) and drag the file into it. If you haven't used the file after several months, then it's probably safe to delete it.

By the way, avoid mixing work files with program files. Store your work files in a separate directory (or subdirectory) instead. This will make it easier to keep track of your work files and prevent accidental deletions of wanted program files.

Finally, if you no longer use a program, then why leave it sitting on the hard disc? It can always be reinstalled at a later date if need be.

Step 2: Run Chkdsk Regularly

When a program crashes, it can create lost allocation units (file segments) which, over time, will eventually occupy lots of hard disc space. To retrieve this space, first quit all applications, including Windows and MS-DOS Shell, and go the root directory of the drive you want to check. Now type chkdsk /f.

If lost allocation units are found, a screen prompt appears asking if you want to convert the lost chains to files. If you press N, the lost chains are deleted and your disc space is freed.

Conversely, if you press Y, Chkdsk converts the lost allocations units to files (eg, FILE0000.CHK, FILE0001.CHK, etc) and stores them in your root directory. You can then examine

Watch Out For Computer Viruses

The six basic steps listed in this article are all essential for good hard disc maintenance. But there's one more thing that you should do to keep your hard disc healthy – scan it regularly for viruses.

In fact, you can virtually eliminate the risk of a virus by scanning every floppy disc that goes into the machine. Be particularly diligent with those obtained from an outside source.

A virus checker comes with MS-DOS 6.0 and above but unfortunately it's not cheap to update on a regular basis. The one used at SILICON CHIP is McAfee's ViruScan. It is updated on a regular basis and has detected viruses on incoming floppy discs on quite a few occasions. The Stoned virus is the most common but it has also saved us from other nasties, including the dreaded Michelangelo virus.

McAfee's authorised agent in Australia in Doctor Disk. You can contact them in Sydney on (02) 281 2099 and they also have offices in Melbourne, Canberra, Perth, Brisbane and Adelaide.

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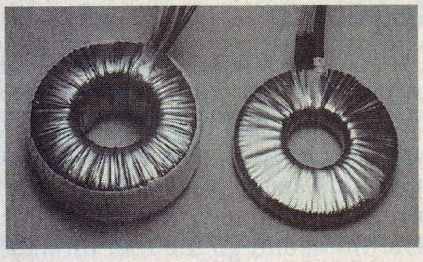

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UNDLLLIL LXL      26420 10-03-93   6:00a
UNFORMAT COM      12738 10-03-93   6:00a
VFLNFO   DOC       5295 10-03-93   6:00a
VGA      GRB       4421 09-04-91   5:00a
VGA      VLD       9462 09-04-91   5:00a
VGAMONO  GRB       4430 09-04-91   5:00a
VSAFE    COM      62576 10-03-93   6:00a
WNTOOLS  GRP       3741 10-02-95   5:25p
XCOPY    LXL      15820 10-03-93   6:00a
      165 file(s)    5251006 bytes
                   163069952 bytes free

C:\TEMP>dir *.tmp

 Volume in drive C is SILICHIP1
 Volume Serial Number is 3028-1DF2
 Directory of C:\TEMP

~WRD659  TMP          0 27-02-95   6:04p
~PW50B76 TMP          0 27-02-95   4:43p
~WRL3635 TMP     436810 27-02-95   6:04p
        3 file(s)     436810 bytes
                   163069952 bytes free

C:\TEMP>
```

Fig.1: temporary (.tmp) files can soon clog up a hard disc if not cleaned off regularly. These files can be left on the hard disc if Windows crashes or a Windows application stops running unexpectedly. Be sure to exit Windows before deleting .tmp files – see text.

the contents of these files and retrieve any data that you might want to keep. The .CHK files should then be deleted using the del command.

More information on chkdsk can be found in your MS-DOS manual. By the way, it's always a good idea to run Chkdsk before running Defrag or DoubleSpace (see below).

Step 3: Delete Temporary Files

Windows applications create temporary files on the hard disc while they are running. These files always have a .TMP extension and they should all be automatically deleted when you exit Windows. However, if Windows or a Windows application crashes, or you switch off the computer without leaving Windows, these temporary files can be left scattered on the disk.

Eventually, temporary files can occupy a huge amount of hard disc space, so it pays to delete them regularly. How do you know where these files are? Just take a peek at your autoexec.bat file. To view it, go to the root directory (eg, C:\) and enter "type autoexec.bat". Temporary files will be written to the directory specified by the line SET TEMP=C:\directory.

All you have to do is go to that directory and erase all the .TMP files. Don't do this from inside Windows, though – you must exit Windows first, otherwise you will erase valid .tmp files that are in use.

Actually, its a good idea to create a separate "temp" directory and edit the line in your autoexec.bat file to read "SET TEMP=C:\TEMP". That way, the .TMP files will be written to the temp directory and will not get mixed up with wanted files. This will make it easier to delete them (you could even write a batch file to do this).

Alternatively, you can place the temp directory on a RAM disc (if you have one). By doing this, any .tmp files will be automatically erased when the computer is turned off.

Step 4: Zip Up Little-Used Files

Lots of valuable disc space can be retrieved by zipping up little-used files. Two very popular file compression programs are LHArc and PKZIP and these can either be downloaded as shareware from bulletin boards or obtained from software vendors.

Many graphics files will zip up to 20% or less of their original size, so file compression can be very worthwhile. There's just one thing to watch out for here – be sure to delete the original file after zipping it up.

Another approach is to use "compression on the fly". This involves creating a compressed drive on the hard disc using DoubleSpace or some other disc compression program. The advantage of DoubleSpace is that it comes "free" with MS-DOS 6.0 and above. To use it, just follow the instructions in the manual.

Compression on the fly is transpar-

ent to the user. Your files are automatically compressed when they a saved to a compressed drive and can be opened in the normal fashion. You don't have to manually zip files up or unzip them when you want to use them, as with LHArc and PKZIP. On the other hand, your files will not be zipped up as tightly (typically, 2:1) and they will take slightly longer to open and save than files that are not compressed.

Step 5: Defrag The Disc

Having run Chkdsk and deleted all those unwanted files, it's time for a disc tune-up. You can do that by "defragging" the remaining files so that they are written in contiguous (consecutive) blocks on the hard disc.

In normal use, files on the disk can become fragmented. This occurs because there is often not enough contiguous space to store a file and so it is broken into fragments and stored in different locations on the disc. These locations are then stored in a "file allocation table", so that DOS knows where to find the various fragments.

Unfortunately, fragmentation slows the computer down because the disc heads have to move over larger areas of the disc in order to read and write files. The way around this is to run the Defrag utility that's supplied with MS-DOS 6.0 and above and with other software (eg, Norton's Utilities). On a badly defragmented disc, this can give a worthwhile performance boost.

To run the Defrag utility, quit all programs including Windows, go to the DOS prompt, type "defrag" and press <enter>. After that, select the hard disc drive you wish to defrag and choose "OK". The utility will then analyse that drive and recommend a defragmentation option. Choose "Optimise" to begin, then sit back and watch the show as files are shuffled about the disc.

Don't interrupt or switch off while Defrag is running, otherwise you could loose data.

Step 6: Create A Permanent Swap File

When you start Windows in Enhanced mode, it frees up memory by temporarily swapping information to a "swap file" on your hard disc. If you don't have a permanent swap file, then Windows creates a temporary swap file each time it is started. This can shrink and grow in size as required, which means that it can fragment.

A permanent swap file on the other hand is contiguous and will therefore boost performance. To create a permanent swap file, first exit Windows and run Chkdsk and Defrag to optimise the drive and create a large block of contiguous disc space. This done, restart Windows and double-click the Control panel icon in the Main group. Now double-click the 386 Enhanced icon and choose the Virtual Memory button.

Click Change, then choose Permanent from the Type list. You can now either accept the size recommended by Windows or type in a new figure if you wish to alter this. Finally, click OK and click Restart. Windows will now restart so that your changes take effect.

A large contiguous swapfile will now be present on the hard disc. In fact, if you run Defrag again, this file can be seen as a large string of Xs (indicating that they are unmoveable). Note that this area cannot be written to by other files, which means that the remaining disc space is shrunk by the size of the swapfile. If hard disc space is at a premium, try using a smaller permanent swapfile or, if you have lots of RAM, try deleting the permanent swapfile altogether. **SC**

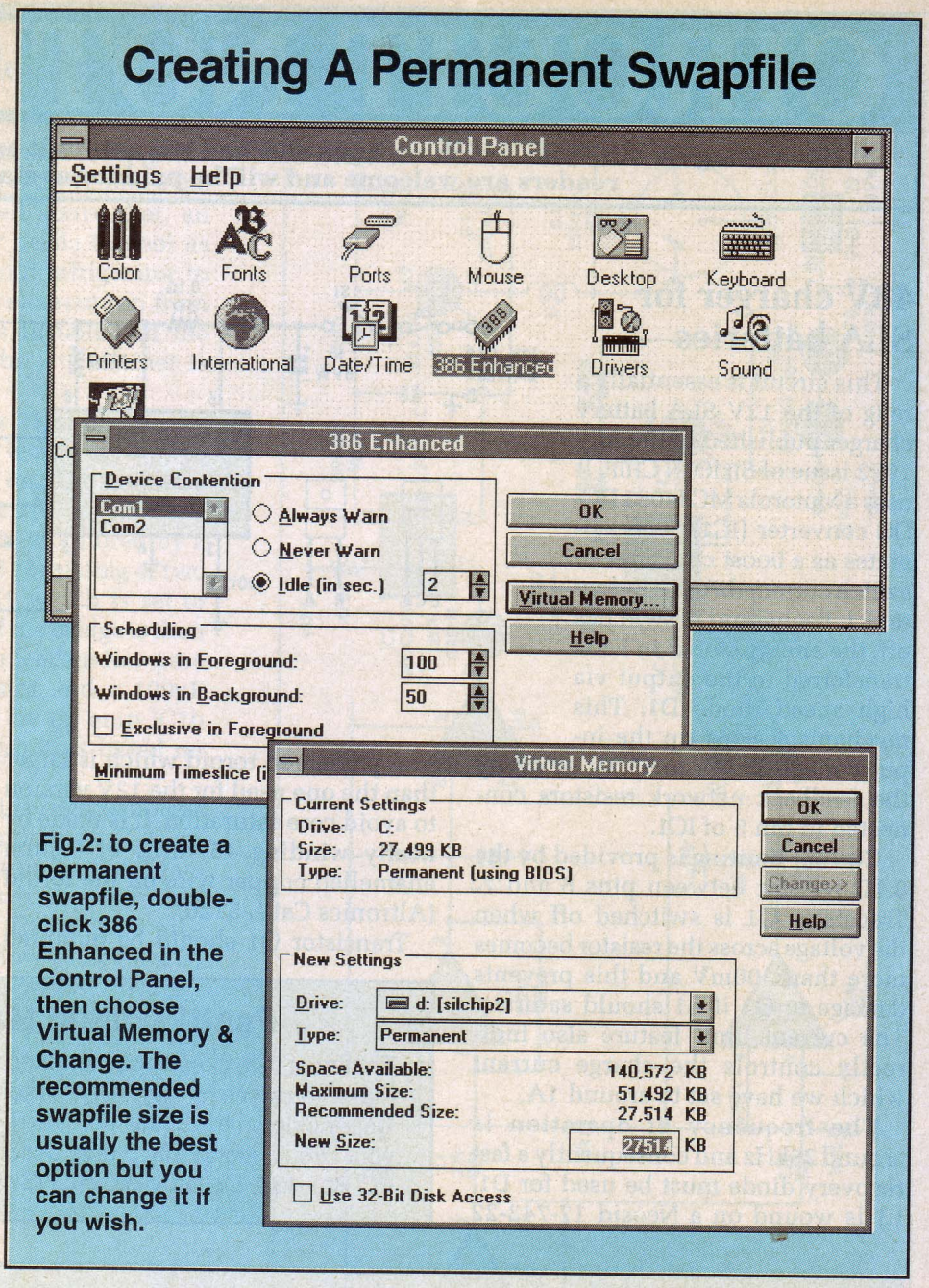
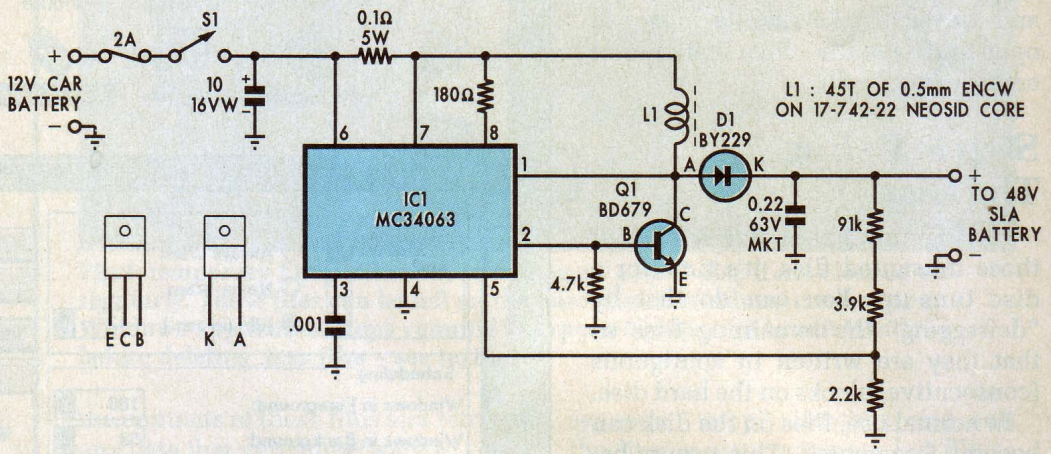


Fig.2: to create a permanent swapfile, double-click 386 Enhanced in the Control Panel, then choose Virtual Memory & Change. The recommended swapfile size is usually the best option but you can change it if you wish.

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

48V charger for SLA batteries



This circuit is essentially a rejig of the 12V SLA battery charger published in the July 1992 issue of SILICON CHIP. It uses a Motorola MC34063 DC-DC converter (IC1). This operates as a boost converter to switch current through inductor L1. Each time Q1 switches off, the energy stored in L1 is transferred to the output via high speed diode D1. This mechanism steps up the input voltage of 12V to 55.2V, as set by the feedback network resistors connected to pin 5 of IC1.

Current limiting is provided by the 0.1Ω resistor between pins 6 and 7. Transistor Q1 is switched off when the voltage across the resistor becomes more than 300mV and this prevents damage to Q1 if L1 should saturate. The current limit feature also indirectly controls the charge current which we have set to around 1A.

The frequency of operation is around 25kHz and consequently a fast recovery diode must be used for D1. L1 is wound on a Neosid 17-742-22 iron powdered toroid which is larger than the one used for the 12V version to avoid core saturation. It is made by neatly winding 45 turns of 0.5mm enamelled copper wire on the toroid (Altronics Cat L-5120).

Transistor Q1 should be mounted on a heatsink with at least 12°C per watt dissipation. A diecast case which is large enough to hold the circuit should be adequate. Note that the transistor must be electrically isolated from the case with a mica washer, etc.

SILICON CHIP

Psstt! Wanna Make Some Money?

That neat little circuit you've nutted out to serve in your latest project could make you some money. Why not send it to us for publication in these pages? Depending on the circuit merit and complexity, we will pay up to $50. Send your circuit, along with a brief description of how it works, to SILICON CHIP, PO Box 139, Collaroy Beach, NSW 2097. Or fax it to us at (02) 979 6503.

Tachometer pick-up for diesel engines

This add-on circuit allows the Digital Tachometer described in the August 1991 issue of SILICON CHIP to be used with a diesel engine. A pick-up coil is used to detect two magnets which are installed with equal spacing on the harmonic balancer. The original points detecting circuit connected to the base of transistor Q1 is modified to suit the coil output signal.

Normally, transistor Q1 is held off because its base current from the 10kΩ resistor is shunted away by diode D1 and coil L1. When a magnet spins past the coil, the generated voltage reverse biases D1 and transistor Q1 is then able to turn on. The .01µF capacitor prevents multiple triggering of Q1 by slowing down the switching rate.

The magnets are placed so that the north pole is facing outwards, with the south pole against the harmonic balancer. Alternatively, the south pole could be facing outwards provided that both magnets are arranged with the same polarity.

The coil is made by winding 300 turns of 0.25mm enamelled copper wire onto a 6mm steel bolt. Apply insulation tape to the bolt thread first and secure the coil with insulating tape or heatshrink tubing. The bolt is attached with nuts onto a mounting bracket and positioned so that the head has a 2-3mm gap between it and the magnet faces.

Note that the polarity of the coil is important for correct operation of the circuit. Swap the coil lead connections if it does not operate correctly.

The Digital Tachometer circuit should be calibrated as for a 4-cylinder engine; ie, R_X should be 82kΩ and VR1 should be adjusted for a reading of 1500 RPM during the suggested calibration procedure with a 50Hz frequency reference.

Note: back issues of August 1991

Temperature controller for home brewers

To make a good beer it's important to keep the temperature of the brew constant at 26°C. Since the ambient temperature can be well above that, an effective temperature controller needs to cool as well as heat. This one uses an old refrigerator to provide the cooling and a heater element run from 32VAC. The heating element is installed in the bottom of the fridge while the brew container is installed on a shelf above.

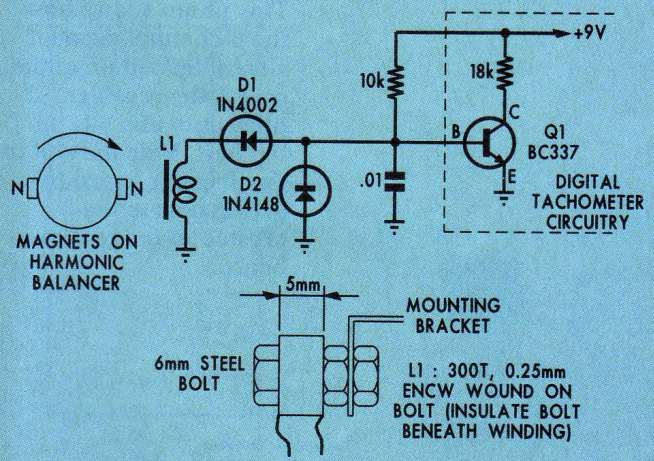
If the temperature goes below 25°C, the heater element is turned on and if the temperature goes above 27°C, the fridge is turned on. The resulting temperature control is quite effective.

The temperature of the brew is monitored by a thermistor, R_{th}, in a bridge circuit consisting of two 120kΩ resistors and trimpot VR1 which is set to about 95kΩ at 26°C. The output of the bridge is then amplified by op amp IC1a which feeds a low pass filter consisting of a 10kΩ resistor and a 100µF capacitor. This filter is buffered by op amp IC1b which then drives a set of comparators based on IC2.

Comparators IC2a & IC2b provide high temperature sensing (ie, above 27°C) and drive IC3, an MOC3021 optocoupler, which turns on the Triac. This turns on the refrigerator, which runs from 240VAC. Similarly, comparators IC2b & IC2d provide low temperature sensing (below 25 degrees C) and drive IC4, another MOC3021 which turns on Triac TR2 and the heater element which runs from 32VAC.

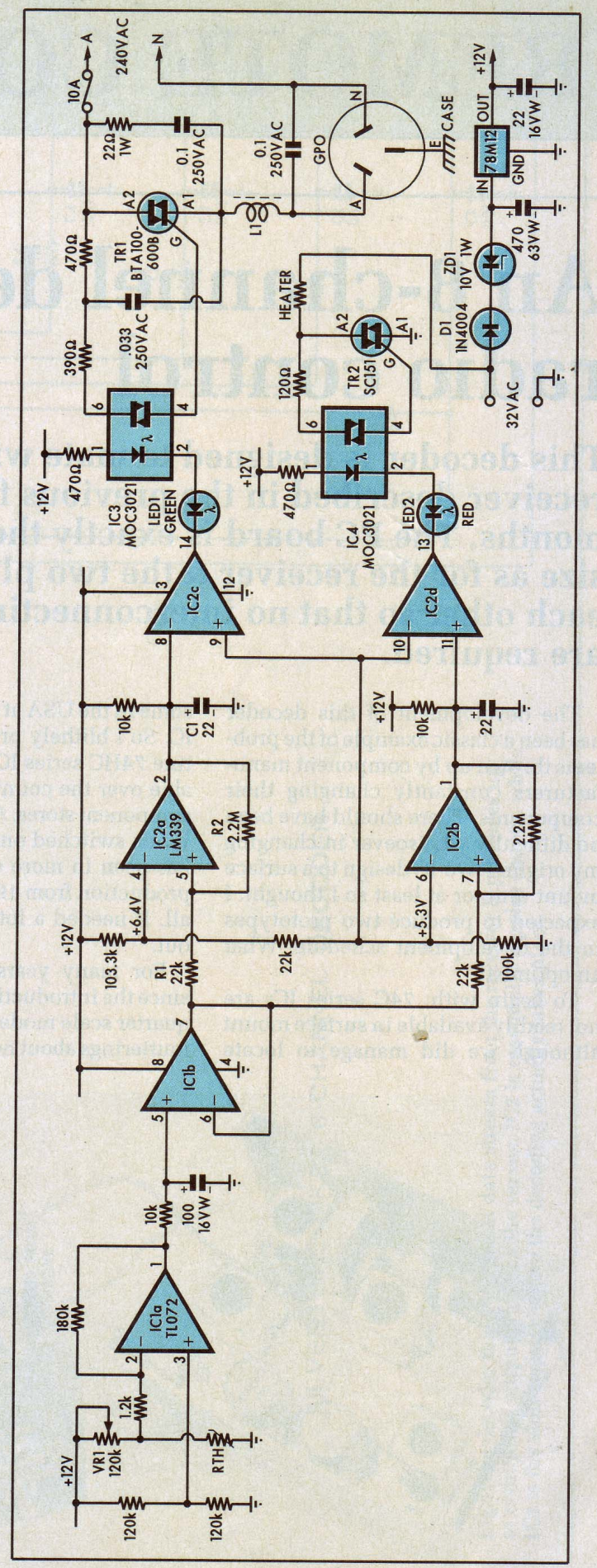
A small heatsink is required for each Triac. A suitable heater element can be made by connecting a number of jug elements in parallel.

Paul Chen,
Dundas, NSW $45.



are still available at $7.00 including postage.

John Clarke,
SILICON CHIP



REMOTE CONTROL

BY BOB YOUNG

An 8-channel decoder for radio control

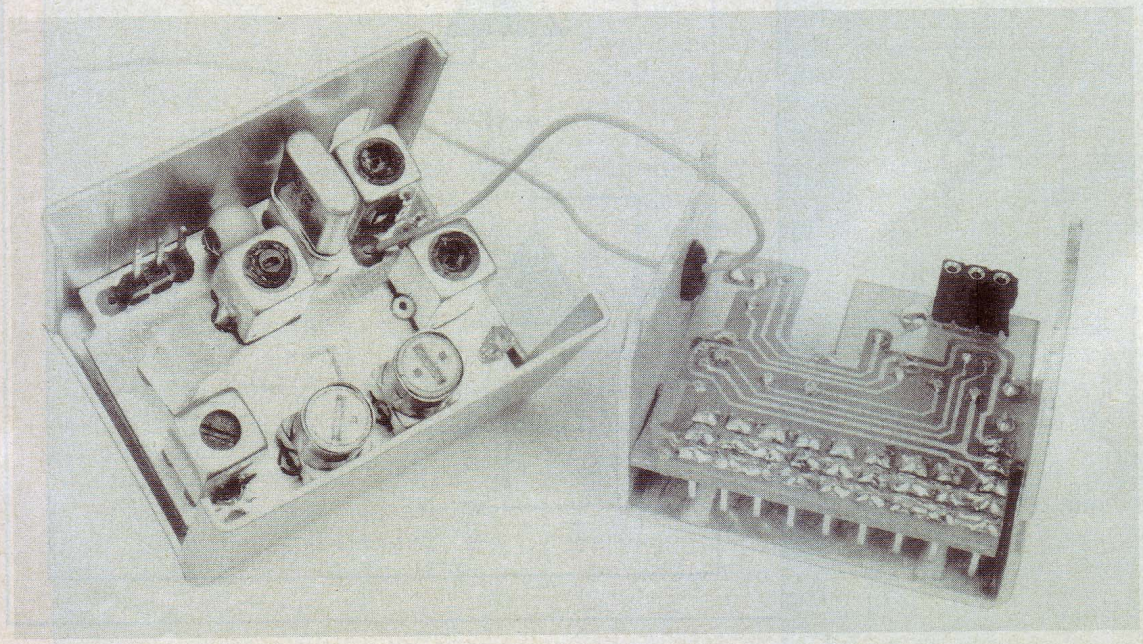
This decoder is designed to mate with the AM receiver described in the previous four months. The PC board is exactly the same size as for the receiver & the two plug into each other so that no interconnecting wires are required.

The development of this decoder has been a classic example of the problems thrown up by component manufacturers constantly changing their components. There should have been no difficulty whatsoever in changing my original two-IC design to a surface mount unit, or at least so I thought. I expected to produce two prototypes in the development schedule. What an optimist!

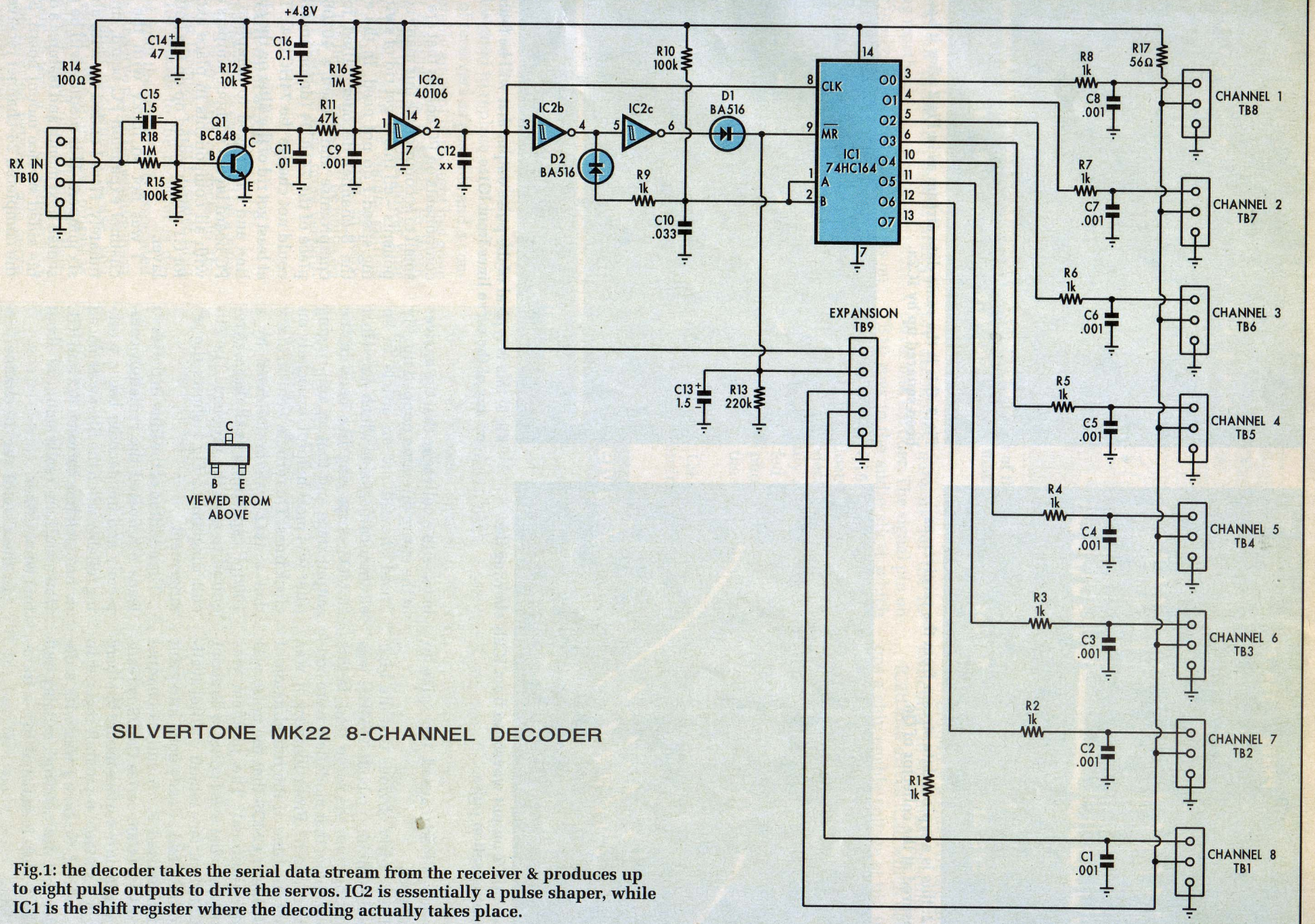
To begin with, 74C series ICs are not readily available in surface mount although we did manage to locate some in the USA at about US$3.50 per IC. So I blithely proceeded to substitute 74HC series ICs which are available over the counter at several large component stores. All hell broke loose. When switched on, the circuit which has been in more or less continuous production from 1974 did not work at all. It needed a lot of work to sort it out.

For many years and particularly since the introduction of the very large quarter scale models, there have been mutterings about noise or interference problems related to the long servo leads in these models. The talk was always vague and no one appeared to have any definite idea as to what was the nature of the noise or where it came from. The implication seemed to be that RF was being picked up on these long leads from other transmitters and was then finding its way back into the receiver – much the same as CB transmitters break into older stereo sets. As a result, we were often asked to fit ferrite beads and all sorts of suppressors to long servo leads. I might add here that I spent hours examining my sets and never located any definite signs of this problem.

When I finally managed to trick the first prototype decoder into working, the very first thing I noticed when I plugged in a servo was a very strong noise spike at the receiver detector, associated with any channel which had a servo lead attached. Removing



This photo shows how the 8-channel decoder sits in the bottom of the case & the receiver plugs into and sits on top of it. Note the slot in the decoder board to give access to the crystal on the receiver board.



SILVERTONE MK22 8-CHANNEL DECODER

Fig.1: the decoder takes the serial data stream from the receiver & produces up to eight pulse outputs to drive the servos. IC2 is essentially a pulse shaper, while IC1 is the shift register where the decoding actually takes place.

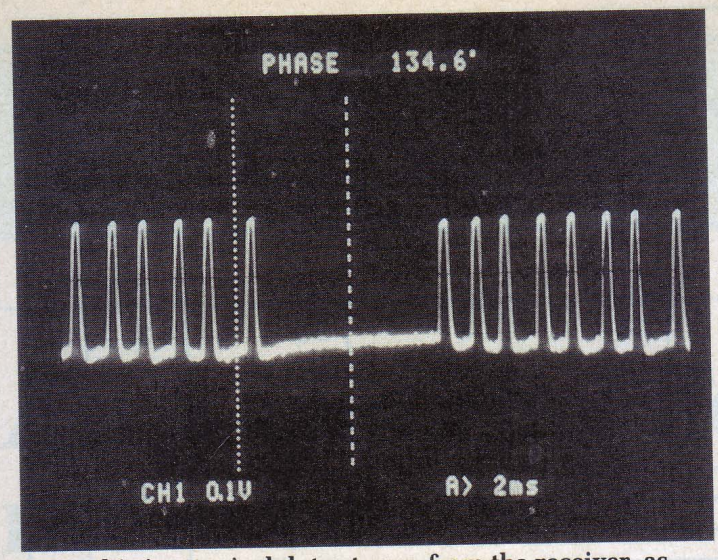


Fig.2: this is a typical data stream from the receiver, as measured at the collector of Q6.

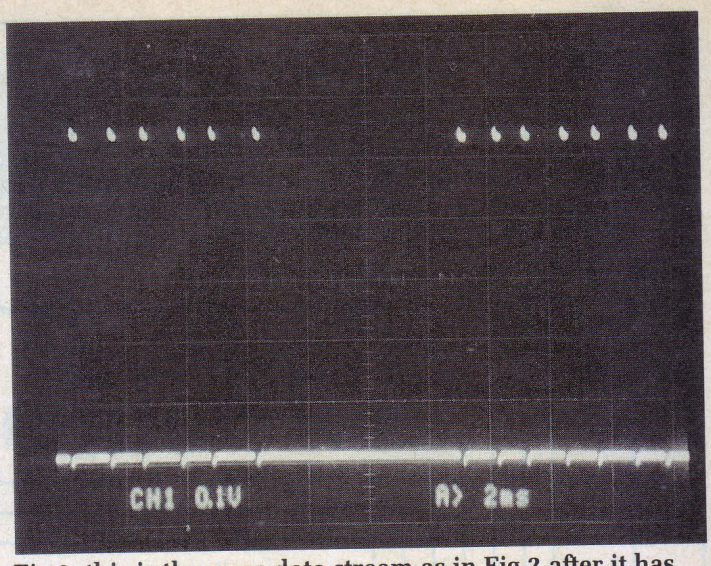


Fig.3: this is the same data stream as in Fig.2 after it has been squared up by IC2a.

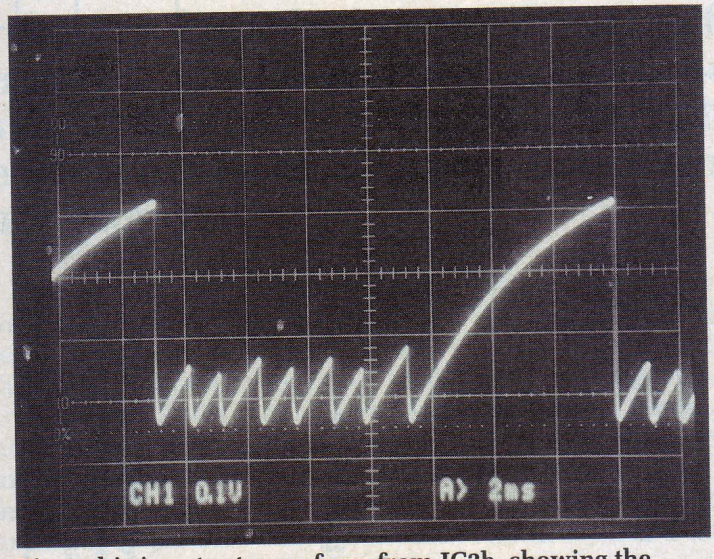


Fig.4: this is output waveform from IC2b, showing the synchronisation pulse.

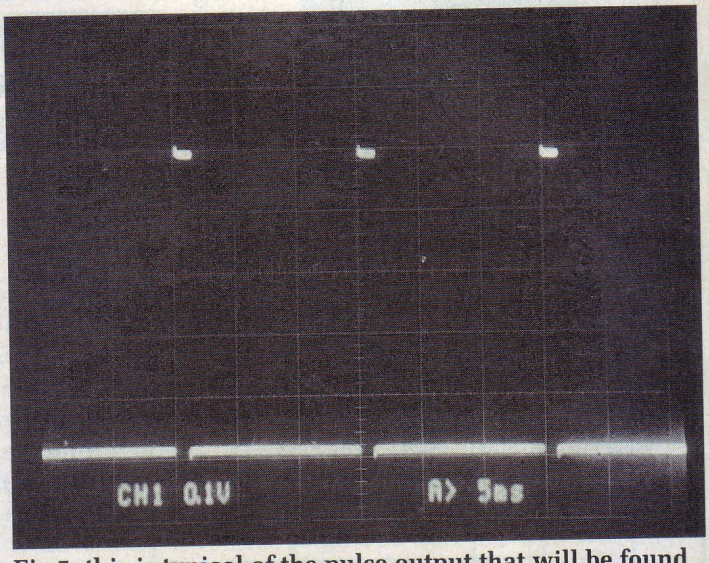


Fig.5: this is typical of the pulse output that will be found on any of the servo lines from IC1.

the servo lead caused the spike to disappear.

It was fairly obvious that the high speed switching (about 15MHz) was radiating from the servo lead. Is this the problem that modellers were concerned about? From memory it was about the time of the introduction of high speed CMOS that the noise was first mentioned. The problem was however, what was I going to do about it? CMOS surface mount was not available and I had already gone into print and promised 8, 16 and 24-channel decoders. (4000-series CMOS is readily available in surface mount but there is not a suitable 8-bit shift register in this series). So here I was with a decoder that did not work reliably and when it did, it radiated like a transmitter.

It was while discussing these problems with a colleague that the answer to the entire dilemma popped up. My friend showed me an article in an electronics magazine which stated that HCMOS chips ring like bells in the output stage and that an anti-ringing filter was most helpful, especially on clock lines. This article went on to say that a 1kΩ resistor followed by a 1000pF capacitor was all that was required to cure the problem. The circuit diagram of Fig.1 shows the arrangement.

The addition of the filter in the servo leads eliminated the radiation completely and the decoder began working reliably when the filter was placed in the clock line between IC2 and IC1. However, I am really annoyed about this whole affair.

In the case of the 24-channel decoder, I am now stuck with adding 51 components on PC boards that are too small to accommodate this many components – all this to get rid of switching speed I do not need. In the end, the 8-channel decoder called for a compromise and I used a 40106 in place of the 74HC04 (unfortunately, I could not change the 74HC164). This at least got rid of the filter on the clock line and I managed to complete the PC board layout without jumpers and with all components in place except for C1 which ended up on the bottom layer.

I was not so lucky with the 16-channel expansion PC board, unfortunately. Here I ended up with about six jumpers. This module will be presented next month and features a double sided surface mount board. Still, the completed 24-channel receiver is a very professional looking piece of

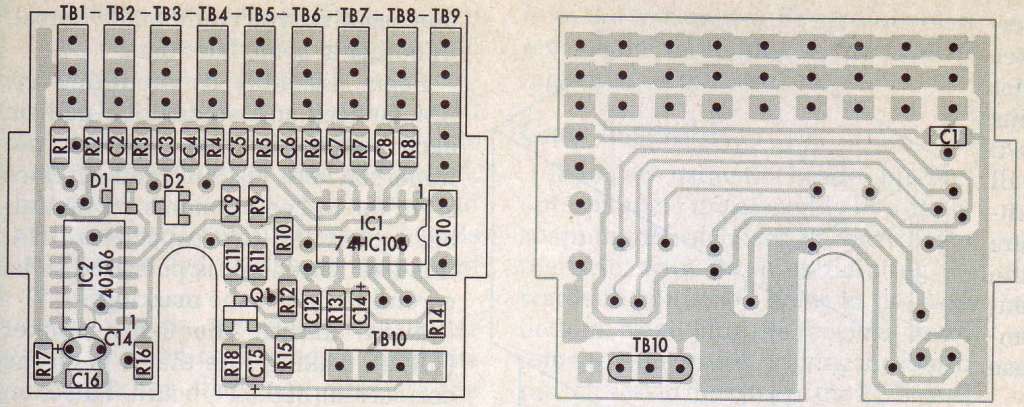


Fig.6: here are the component overlays for the top & bottom of the 8-channel decoder board. Only a single capacitor (C1) & the 3-way header are mounted on the underside (see text).

work. All of the PC boards simply plug together.

Finally, I have just a few words on the servo leads themselves. One of the problems faced by modellers with older equipment is the need for replacement receivers. The transmitters never seem to wear out and servos are fairly robust but receivers often die and the agents often discontinue service on older models. This leaves the modeller with an unuseable system. Added to this is the confusion brought about by non-standardisation of the servo plugs. Most servos these days plug into header pins mounted directly onto the PC board but the arrangement of these header pins can vary from manufacturer to manufacturer.

This new receiver/decoder package is designed to replace as wide a variety of receivers as possible and a considerable amount of thought has gone into making this possible. To begin with, the polarity of the power pins may be reversed by simply cutting two tracks and jumpering. In addition, the header pins may be replaced with fly leads for even more versatility.

Circuit operation

The decoder is contained on a separate PC board and connects to the receiver through a 4-pin header plug (TB10). Power to the receiver is derived from the power rails associated with the servo plugs. Depending upon the number of channels in use, you can either use a spare servo output as the power input or if all eight channels are in use, a "Y" or splitter lead can be inserted between one servo and header pins.

R17, R14, C14 and C16 form a supply decoupling network for the receiver and decoder. The signal pin on TB10 goes to the audio slicer which consists of Q1, C15, R18, R15 and R12. The input floats on the receiver noise floor and rejects the bottom 1V of hash. Thus only clean high level audio pulses are fed to the audio amplifier. The scope photo of Fig.2 shows the signal from the receiver (at the collector of Q6).

C11, R11 and C9 form a filter to remove any remaining hash. The 40106 (IC2) is used as a pulse shaper and driver for the 74HC164 shift register (IC1). Inverter IC2a provides the clock data (as shown in the scope photo of Fig.3) and also drives IC2b. IC2b's output supplies the synchronisation pulse (shown in the scope photo of Fig.4) in association with D2, R10 and C10. During the long pause between pulse frames (6ms minimum), C10 charges via R10 and lets pins 1 and 2 on IC1 go high, ready for the first pulse on the next frame. R9 is included to introduce a small delay in the switching, to stop mistriggering.

IC2b also drives IC2c which develops a chip enable voltage at pin 9 on IC1. This acts as a fail-safe in the absence of the incoming pulse train and thus helps to stop servo gears being damaged. C13 and R13 smooth out the pulses and provide approximately +4.5V DC on pin 9, thus enabling the chip. Loss of signal sends pin 9 low, shutting down IC1 and completely eliminating spurious outputs on the servo lines.

Receiver & Decoder Kit Availability

Receiver PC board (double-sided with plated-through holes)	$11.50
Basic receiver kit: all parts except crystal	$45.00
Built & tested AM receiver less crystal	$59.00
Decoder PC board (double-sided with plated-through holes)	$11.50
8-channel decoder kit: all parts less servo pins or connectors	$32.00
Built & tested 8-channel decoder but less servo plugs	$45.00
Expansion kit: all components to build the 16-channel decoder	$42.00
Built & tested 16-channel decoder less servo connectors	$55.00
8-channel receiver case (includes labels)	$11.50
16-channel receiver (includes labels)	$19.50
Machine wound RF coils	$2.95
Machine wound IF coils	$2.95
Crystals (AM) per pair	$17.95
Servo header pins (each)	$0.12
Futaba EXT lead	$3.40
J.R. EXT lead	$3.40
Sanwa EXT lead	$3.40

Notes:

(1). When ordering crystals, do not forget to specify frequency.
(2). All orders should add $3.00 for postage and packing. Payments may be made by cheque, money order, Bankcard, Visa Card or Mastercard. Send all orders to Silvertone Electronics, PO Box 580, Riverwood, NSW 2210. Phone (02) 533 3517.

Provided the conditions are all correct on pins 1, 2, 8 and 9, the pulses will clock through the shift register and servo outputs will appear at pins 3, 4, 5, 6, 10, 11, 12 and 13, as shown in the scope photo of Fig.4 (ie, if all eight pulses in a frame are transmitted). If only two pulses per frame are transmitted, then output 3 will be the sync pause and output 4 will be channel 1 again and output 5 will be channel 2; output 6 will be the sync pause and so on.

Thus, in a 24-channel receiver channel 1 will appear three times if only eight pulses are transmitted. This is a useful feature during testing if only transmitters with a lesser number of channels are available or it can be very useful as a splitter/driver for parallel servo operation. In this case, each output only drives one servo as against two in the case of a "Y" lead.

The three unused inputs on IC2 (pins 9, 11 & 13) are tied to ground. Finally, TB9 is the expansion port for the 16-channel add-on PC board. This port carries clock, data and enable information, as well as the two power rails.

Construction

The PC board provided with the kit is a double sided plated-through board with solder resist over all but the component pads. For those not familiar with surface mount assembly, read the article on this subject in the January 1995 issue of SILICON CHIP.

The component overlays for the top and bottom of the boards are shown in the diagrams of Fig.6. First, the polarisation of the power rails must be decided and set accordingly. As delivered, the PC board is set up for centre rail positive (JR, Futaba, Hi Tech). To reverse this order (KO, Sanwa), simply cut the thin tracks connecting the power rails with the decoder supply rails (along the top edge of the board as shown in Fig.6) and reconnect them to the appropriate rails. There are pads located alongside the power rails for this purpose. Note that one track is located on the top layer and the other on the bottom layer. Use 10-amp fuse wire or a component lead for the jumper.

No reverse voltage protection

Be very careful here for there is insufficient voltage for a reverse voltage protection diode when using a 4.8V battery. Whilst on this subject, the receiver is set up for 4.8V and will not operate satisfactorily from a 6V battery. If you need to operate from 6V then insert two diodes in series with the +6V lead, to reduce the voltage by 1.2V. Be certain to mark your finished unit *clearly* because if you end up with two receivers, one positive and one negative, you could land yourself in bother at some later date.

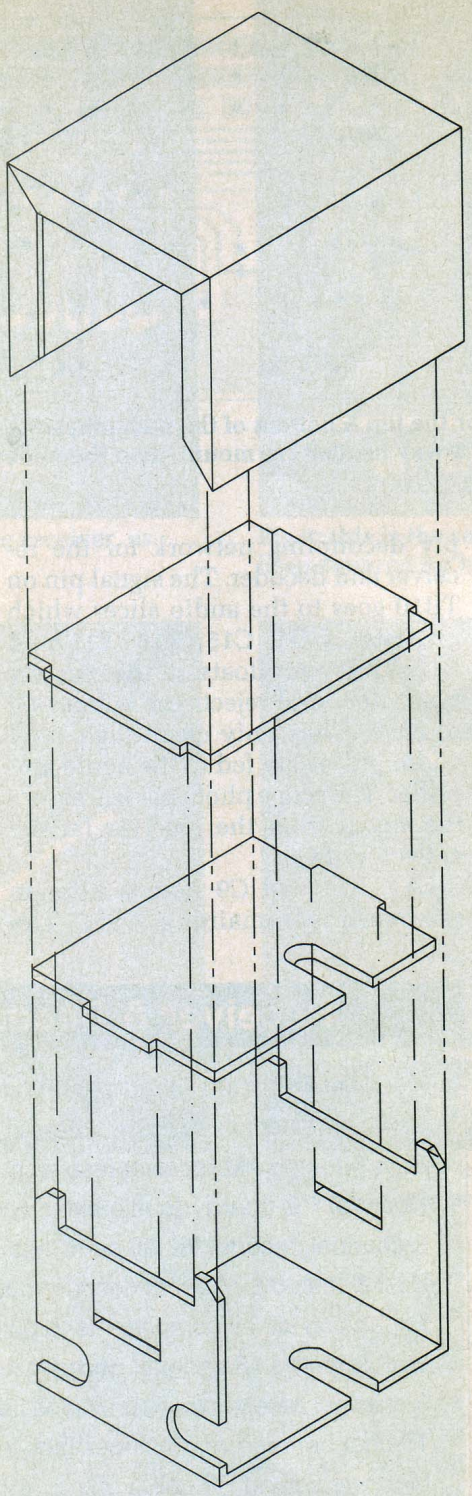


Fig.7: this exploded diagram shows how the decoder & receiver sit in the case. The various slots in the case give access to the crystal & provide exit holes for the antenna & servo lines.

Begin assembly by mounting the SM devices and solder one pad on each component first. Order is not important here, just suit yourself. Once all of the SM components are mounted, mount the two capacitors. C14, the 47µF tantalum, is polarised so be careful to follow the markings.

Next, mount the 3-pin socket (TB10), making sure that it is on the correct side of the PC board. This is on the *opposite* side to the components. If the thought of having a plug in the systems worries you in regard to vibration, then this connector pair may be deleted and replaced with wire connections.

At this point, it needs to be clearly understood how many channels will be required and whether fly leads or pins are to be used for the servo connectors. Presumably you have ordered a kit and specified the number and type of servo connectors required. If you are using fly leads, just solder the leads into the appropriate holes in the servo connector pads in the order they lay on the servo lead.

If the leads are centre-negative, do not forget to reverse the PC board connections if you have not already done so. If you do decide to use fly-leads for the servo outputs, you will need to file one or two slots in the case end for the lead exits. Do not forget to thread the servo leads through the grommets before soldering them to the PC board (see the exploded case diagram of Fig.7 for details).

If you intend to use the pins, then just simply push the 3-pin plug through the PC board with the plastic base on the component side and with the long pins going through the holes. Solder the pins from the reverse side. Snip off the excess pins on the reverse side and remove the plastic from the pins on the component side. This now leaves pins the correct length for a servo socket on the component side of the PC board.

If you intend using more than eight channels, you must now install the expansion port. Follow the same routine as for the servo pins. You now have a finished decoder.

Testing

Plug the decoder into a pre-tuned receiver and leave both units out of the case. It is wise to insert a piece of

insulating card between the two boards, as otherwise they can touch if bumped. Once they are snapped into the slots in the case, this is not necessary. Testing can now proceed as all components are accessible from the servo pin side of the PC board. Alternatively, an extension lead can be made up to keep the two PC boards well separated during servicing and testing.

Turn on the associated transmitter and, using an oscilloscope, check the input to the slicer and compare the waveshape with Fig.2. Next proceed to check pins 1-6 on IC2. These should compare with Fig.3 on the odd-numbered pins and should be inverted on the even-numbered pins.

Now test IC1 pins 1 and 2 and compare the waveshape here with Fig.4. Pin 8 on IC1 compares with Fig.3 and pin 9 should be a DC voltage with a low level of ripple on top floating at about +4.5V above ground. Whilst monitoring pin 9, switch off the transmitter and note that it goes low no more than one second after switch off.

If all of the foregoing is in order, the output at pins 3, 4, 5, 6, 10, 11, 12 & 13 will look like Fig.5. Plug in one or more servos and check the operation from the transmitter. Be careful not to reverse the servo plug as the polarising key is in the case.

Case assembly

If you are using the header pin layout, complete the assembly by simply snapping the decoder PC board into the case, with the pins pointing towards the punched holes in the case bottom. Next, plug the receiver board into the 3-pin socket, leaving the fourth pin (closest to the edge of the PC board) outside the socket. This now provides a useful test point to attach an oscilloscope or meter. The receiver simply rests in the notch in the case sides.

Slip on the case lid, attach the labels and open the servo slots in the bottom label that you wish to use. Leave any of the unused slots covered to prevent ingress of dust. Secure the lid with a wrap of clear tape. Now go and have some fun.

Troubleshooting

Now for the sad cases, it is back to the test bench. First, check the assembly for missing components, soldering faults, etc. Check the decoder power rails to see if they are compatible with the servo leads you are using. Be sure that these have not been accidentally reversed and do not suit the servo leads you are using.

Now grab your multimeter and start testing voltages. The input voltage at the power rails will be the battery voltage unless dropping diodes are installed. Next, check the power rails in the decoder. With a nicad battery reading 5.0V, pin 14 on both chips should be approximately 4.9V. Pin 7 on both chips is the ground pin. The base of Q1 should be +0.35V and the collector +4.9V, with no signal from the transmitter.

The rest is routine servicing. If all of the DC and input voltages are correct, then you may suspect a faulty IC, but let me tell you, it is rarely ever the IC. I have found from experience that 99 times out of 100, it is an associated fault.

If all your best efforts are to no avail, then send it back to Silvertone and we will sort it out for you.

Next month, we will describe the 16-channel decoder board. This will be a double-side board with surface mount components on both sides. **SC**

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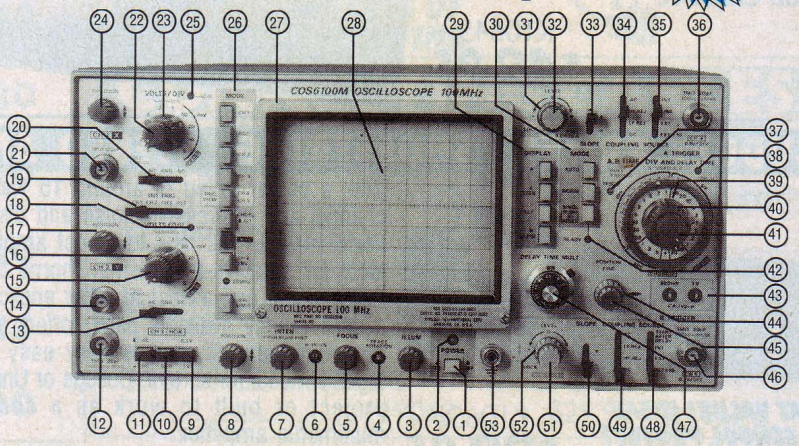

1. Power switch
2. LED
3. Graticule illumination switch
4. Trace rotation
5. Trace focus
6. Trace intensity for B sweep mode
7. Brightness control for spot/trace
8. Trace position
9/10/11. Select input coupling & sensitivity of CH3
12. Vertical input terminal for CH3
13. AC-GND-DC switch for selecting connection mode
14. Vertical input terminal for CH2
15/22. Fine adjustment of sensitivity
16/23. Select vertical axis sensitivity
17/24. Vertical positioning control
18/25/38. Uncal lamp
19. Internal trigger source CH1,CH2,CH3,ALT
20. AC-GND-DC switch for selecting connection mode
21. Vertical input terminal for CH1
26. Select vertical axis operation
27. Bezel
28. Blue filter
29. Display selects A & B sweep mode
30. Selects auto/norm/single sweep modes
31. Holdoff time adjustment
32/51. Trigger level adjustment
33/50. Triggering slope
34/49. Select coupling mode AC/HF REJ/LF REJ/DC
35. Select trigger signal source Int/Line/Ext/Ext÷10
36. Vertical input terminal for CH4
37. Trigger level LED
39. A time/div & delay time knob
40. B time/div knob
41. Variable adj of A sweep rate & x10 mag
42. Ready lamp
43. Calibration voltage terminals
44. Horizontal positioning of trace
45. Fine adjustment
46. Vertical input terminal for CH5
47. Delay time MULT switch
48. Selects between continuous & triggered delay
52. Trace separation adjustment
53. Ground terminal

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A PHOTOGRAPHIC TIMER FOR DARKROOMS

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Silicon Chip April '95

K10665
CALL FOR INFO & PRICING
NEW

DIGITAL TRIGGER ADAPTOR FOR SCOPES

With eight inputs (expandable to 24), this useful device will monitor almost any digital circuit and trigger your oscilloscope only when a preset combination of inputs is found. It also includes an adjustable triggering delay, so it can effectively convert your scope into a low cost logic analyser.

EA ***April '95***

NO PICTURE AVAILABLE AT TIME OF PUBLICATIONS

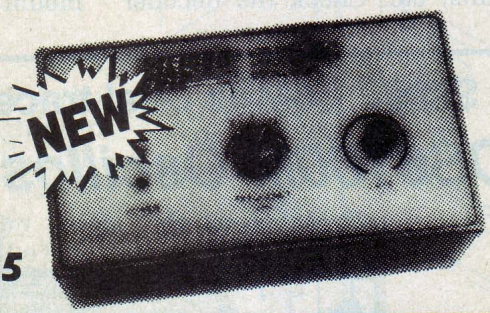
NEW

K10660
CALL FOR INFO & PRICING

3-SPOT LOW DISTORTION SINEWAVE OSCILLATOR

This sinewave oscillator is ideal for testing audio equipment & loudspeakers. It provides three switch-selectable spot frequencies at 100Hz, 1kHz & 10kHz, with levels up to 3V RMS & less than 0.004% distortion.

Silicon Chip Dec' 94



K10645
$49.95

A BUDGET PRICED "SHOESTRING" STEREO AMP

GREAT VALUE! IDEAL FOR SCHOOL PROJECT OR MULTIMEDIA.

K10650
$99.95

With a power rating of around 15 watts per channel and impressive noise and distortion performance, this new low cost amplifier is ideal for small hi-fi systems, "home theatre" installations, and a host of other applications. It uses readily available parts, offers a basic range of features, and is very easy to put together. Ideal for school. College or University project or built to work as a computer multimedia amplifier.

EA Dec'94

BEGINNER'S VARIABLE DUAL-RAIL POWER SUPPLY

If you are just beginning in electronics, then you'll properly baulk at building a mains-operated power supply. This project uses a plugpack which means that you can make your own variable dual-rail power supply without worrying about mains wiring. Needs plug pack M19017. ***Silicon Chip Oct '94***

NEW LOWER PRICE!!

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~~$59.95~~
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PLUG PACK

A plug in style power supply with fixed 16VAC output ideal for use with alarm control panels. Tinned ends for hard wiring to the panel. Australian safety standard AS3108

INPUT: 240VAC 50Hz
OUTPUT: 16VAC unregulated
CURRENT: 1500mA

M19017
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K10045	ETI 480 100W AMP	$34.95
K10050	ETI 480 POWER SUPPLY	$28.95
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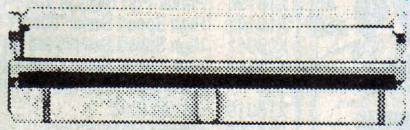

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DB25 Plug Solder Line Male	P10900	$1.75	$1.25
DB25 Socket Solder Line Female	P10901	$1.85	$1.30

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	CAT No.	WAS	IS NOW
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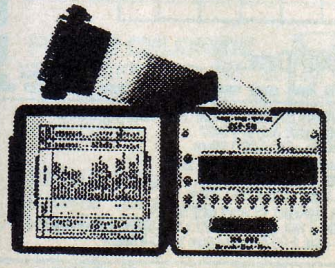
9F/25M	X15669	$9.95	$6.25



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P19070 Serial cable with both DB25 and DB9 female connectors at both ends
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P19072
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WAS **$34.95**
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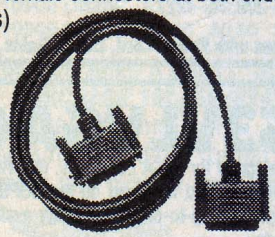

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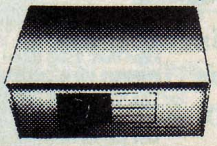

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X18077	512K TRIDENT VGA	$89
X18004	IDE/SPG	$29
X18013	IDE	$19
X17072	ADAPTEC SCSI 16bit 1522A	$199
X18161	*16bit ETHERNET NE2000	$99
X18169	16bit NE2000+	$269
X18151	S.P.G.	$25
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X18190	Printer Port Slct Lpt 1-2-3 Card	$39
X18141	High Speed Serial Card 1-Port 16550	$59.95
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Resolutions	1M DRAMS	2 M DRAMS
640 x 480	256, 64K, 16M	256, 64K, 16M
800 x 600	16, 256, 64K*	16, 256, 64K*
1024 x 768	16, 256	16, 256, 64K*
1152 x 864	256*	256*
1280 x 1024	16*	16, 256*

**This mode may require Multi-Sync Monitor, e.g, NEC 4FG, ADI Microscan 3E*

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CAT.	DESCRIPTION	PRICE
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X18099	VESA 1 Meg TRIDENT 9400	$129
X18100	VESA CIRRUS 5428	$139
X18187	VESA PARADISE BAHAMA 1Meg	$349
X18390	VESA PARADISE BAHAMA 2 Meg	$429
X18186	VESA IDE Cache Cont	$349
X17071	VESA SCSI 2, IDE, Floppy, Multi I/O	$299
X18087	VESA WD Accelerator Video Card	$209
X18167	VESA VGA S3 Accelerator	$149
X18185	VESA ET-4000 TSENG LABS	$245
X18149	VESA CLOUD9 VGA 2 MEG	$449
X18047	VESA IDE ENHANCED MULTI I/O	$139
X18182	VESA CACHED IDE MULTI I/O	$280

P.C.I.

CAT.	DESCRIPTION	PRICE
X17078	PCI SCSI IDE FLOPPY MULTI I/O	$299
X17900	PCI 1M VGA	$249
X18179	PCI IDE CONTROLLER	$69
X18181	PCI DIAMOND VIPER 2MEG	$799

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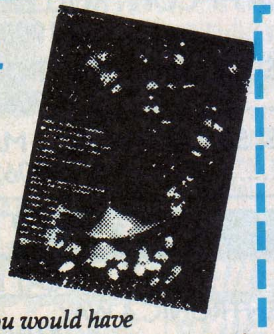

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W12616	16way	$2.20
W12620	20way	$2.50
W12624	24way	$2.90
W12625	25way	$3.20
W12626	26way	$3.60
W12634	34way	$3.90
W12636	36way	$3.90
W12640	40way	$4.90
W12650	50way	$5.90
W12660	60way	$6.90

ON SUPA SPECIAL

GENERAL PURPOSE TRANSISTORS

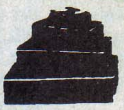
PN100: a NPN general purpose medium power amp and switch with continuous collector current up to 500mA. PN200: a PNP general purpose amp at collector currents to 1 AMP. Both are TO-82 plastic package.

PN100 REPLACES:
PN2221, PN2222, PN2222A, PN3585, PN3568, PN3569, PN3643, PN5133, 2N2219A, 2N2222A, 2N3414, 2N3415, 2N3416, 2N3417, 2N3700, 2N3704, 2N3904, 2N4123, 2N4124, 2N4401, 2N5088, 2N5210.

PN200 REPLACES:
PN2907, PN2907A, PN3638, PN3638A, PN3640, PN3644, PN4121, PN4143, PN4248, PN4249, PN4250, PN4355, PN4916, PN4917, PN5910, 2N205A, 2N3467, 2N3702, 2N3906, 2N4125, 2N4126, 2N4291, 2N4402, 2N4403, 2N5086, 2N5087, 2N5447.

PN100.....T90001
PN200.....T90002

1-9	10+	100+
$0.20	$0.18	$0.15



ALL PLASTIC UTILITY BOXES

Comes with 4 Screws
Black in colour.

	1-9	10+
H10128 83 x 54 x 28mm	$1.95	$1.70
H10126 130 x 68 x 41mm	$2.50	$1.95
H10122 150 x 90 x 50mm	$3.95	$3.50
H10124 195 x 113 x 60mm	$4.95	$ 4.25

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25% more from RIE at the same prices as our opposition

H10810	250gm	$4.95
H10812	500gm	$7.95
H10814	1Kg	$11.95

DIODES BUY IN BULK & SAVE!

Cat No.		10+	100+	1000+	10K
Z10135	*IN4148*	$0.05	$0.04	$0.03	$0.02
Z10105	*IN4002*	$0.06	$0.05	$0.04	$0.03
Z10107	*IN4004*	$0.08	$0.06	$0.05	$0.04
Z10110	*IN4007*	$0.10	$0.07	$0.06	$0.05
Z10115	*IN5404*	$0.18	$0.14	$0.13	$0.11
Z10119	*IN5408*	$0.20	$0.16	$0.15	$0.14

NICADS

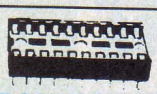
Save a fortune on expensive throw away batteries with these quality Nicads and Rechargers!

Size AA 450mmAH

1-9	10+	100+
$2.95	$2.75	$2.50

Size C 12 A H
$9.95 $9.50 $8.95

Size D 12 A H
$6.95 $5.95 $4.50



LOW PROFILE IC SOCKETS

Save a small fortune on these "Direct import" low profile IC sockets! PCB mounting solder tail. All tin plated phosphor bronze or berrylllum and dual wipe for reliability.

	1-9	10+	100+
P10550 8pin	15¢	12¢	10¢
P10560 14pin	20¢	18¢	15¢
P10565 16pin	20¢	18¢	16¢
P10567 18pin	30¢	25¢	22¢
P10568 20pin	35¢	30¢	25¢
P10569 22pin	35¢	30¢	26¢
P10570 24pin	35¢	30¢	26¢
P10572 28pin	45¢	35¢	30¢

WIRE WRAP IC SOCKETS

These quality 3 level wire wrap sockets are tin plated phosphor bronze.

P10579	8pin	$1.50 $1.40
P10580	14pin	$1.85 $1.70
P10585	16pin	$1.95 $1.80
P10587	18pin	$1.95 $1.80
P10590	20pin	$2.95 $2.75
P10592	22pin	$2.95 $2.70
P10594	24pin	$3.95 $3.50
P10596	28pin	$3.95 $3.50
P10598	40pin	$4.95 $4.50

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- Mounts on smooth non-porous surfaces
- Ideal for holding & other small objects.

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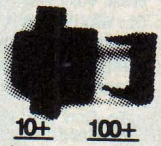
D TYPE IDC PLUGS

	1-9	10+	100+
DE9P 9pin plug			
P12166	$2.95	$2.50	$2.20
DA15P 15pin plug			
P12168	$2.95	$2.50	$2.20
DB25P 25pin plug			
P12170	$4.50	$3.95	$3.50



D TYPE IDC SOCKETS

	1-9	10+	100+
DE9P 9pin socket			
P12167	$2.95	$2.50	$2.20
DA15P 15pin socket			
P12169	$2.95	$2.50	$2.20
DB25P 25pin socket			
P12171	$4.50	$3.95	$3.50

ECONOMY TRANSFORMERS

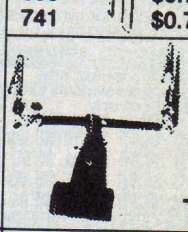
Description	1-9	10+
2155 240V 6-15V 1A		
M12155	$9.95	$8.95
2156 240V 6-15V A2		
M12156	$13.95	$12.95
2851 240V 12-6V CT 250mA		
M12851	$7.95	$6.95
6672 240V 15 30vc 1A tapped		
M16672	$14.95	$12.95

TOGGLE SWITCHES

	1-9	10+
S11010 *S.P.D.T*	$1.20	$1.10
S11020 *D.P.D.T*	$1.30	$1.20

ICB VOLTAGE REGULATORS

Description	1-9	10+	100+
7805UC	$1.00	$0.90	$0.75
7812UC	$1.00	$0.90	$0.75
7815UC	$1.00	$0.90	$0.75
7905UC	$1.00	$0.90	$0.75
7912UC	$1.00	$0.90	$0.75
7915UC	$1.00	$0.90	$0.75
78L05	$0.40	$0.30	$0.28
78L12	$0.40	$0.30	$0.28
LM324	$1.00	$0.90	$0.80
555	$0.75	$0.65	$0.60
741	$0.75	$0.65	$0.60



PC BOARD HOLDER

A must for all PCB work.

T12444 $9.95

QUALITY 3mm LEDS

	1-9	10-99	100+	1K 1000+
Z10140(R)	*$0.15*	$0.12	*$0.10*	$0.08
Z10141(G)	*$0.20*	$0.18	*$0.15*	$0.12
Z10143(Y)	*$0.20*	$0.18	*$0.15*	$0.12
Z10145(O)	*$0.20*	$0.18	*$0.15*	$0.12

QUALITY 5mm LEDS

Z10150(R)	*$0.15*	$0.12	*$0.10*	$0.08
Z10151(G)	*$0.25*	$0.20	*$0.18*	$0.12
Z10152(Y)	*$0.25*	$0.20	*$0.18*	$0.12

DB25 CONNECTOR SPECIALS

	1-9	10+	100+
P10880 DE9P	$1.00	$0.80	$0.60
P10885 DE9S	$1.00	$0.70	$0.60
P10891 DA15S	$1.00	$0.70	$0.60
P18092 DA15C	$1.00	$0.90	$0.60
P10895 DA15S	$1.00	$0.80	$0.60
P10902 DB25C	$1.00	$0.80	$0.60
P10904 DB25P	$1.00	$0.80	$0.60
P10905 DB25S	$1.00	$0.80	$0.60

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Features of the UART include programmable data, format parity, framing and overrun error detection etc.

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	1-9	10+	100+
BC 547	$0.15	$0.10	$0.07
BC 548	$0.15	$0.10	$0.07
BC 549	$0.15	$0.10	$0.07
BC 557	$0.15	$0.10	$0.07
BC 558	$0.15	$0.10	$0.07
BC 559	$0.15	$0.10	$0.07
BC 327	$0.20	$0.15	$0.12
BC 337	$0.20	$0.15	$0.12
BD 139	$0.70	$0.60	$0.50
BD 140	$0.70	$0.60	$0.50

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With Pins for easy board insertion. 10mm diameter, 10mm high.

C10170

1-9	10+	100+	1000+
$1.70	$1.50	$1.20	$0.80

MINI MIC INSERT

Omnidirectional mini mic insert, 6mm diameter. 7mm high.

C10650

1-9	10+	100+	1000+
$2.00	$1.80	$1.30	$1.00

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CPU OPTIONS ..... TAX INC TAX EX
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*15" & 17" Digital Monitor comes with Economy Management Software.

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4M X 8-70 No Parity	$269	$265	$259
4M X 9-70 With Parity	$279	$275	$269
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*These drives come with Disk Management Software to overcome DOS limitations. (Drives will normally go to 525MByte max).

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EPL 5200 *300dpi, 6ppm, laser printer*	$1199
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5¼ DS/HD	$18.95	$17.95

CARDBOARD BOXES DESCRIPTION	1-9	10+
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RS232 2 way Auto	$79.95
RS232 4 way Auto	$124.95
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RS232 2 way Auto	$79.95
RS232 4 way Auto	$124.95
DB9 2 Way	$59.50
DB9 4 Way	$69.50
DB9 & Keyboard 2 Way	$69.50
DB9 & Keyboard 4 Way	$79.50
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Norton Desktop V3/Win	$145	$229
Norton Utilities 8	$145	
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BOX HILL: 1031 Maroondah Hwy. Ph: (03) 899 6033. Fax:(03) 899 0156
ADELAIDE: 241-243 Wright St. Ph: (08) 211 7200. Fax:(08) 211 7273
SYDNEY: 74 Parramatta Rd, Stanmore. Ph: (02) 519 3888. Fax:(02) 516 5024

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Fax:(03) 879 3027 TRADING HOURS: Mon Fri 9am - 5.30pm. Sat 9am - 1pm

City store open till 8pm on Fridays. Box Hill store open till 5pm on Saturdays.

Tax Exempt sales: RITRONICS WHOLESALE Ph.(03) 543 2166 Fax.(03)543 2648
RIE BULLETIN BOARD Ph: (03) 562 7877 For Specials, info & Shareware
MAIL ORDER: Ph:(03) 543 7877 Fax:(03) 543 8295
Mail Order Hotline 1-800 33 5757

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PRODUCT SHOWCASE

Portable DSO & test instrument

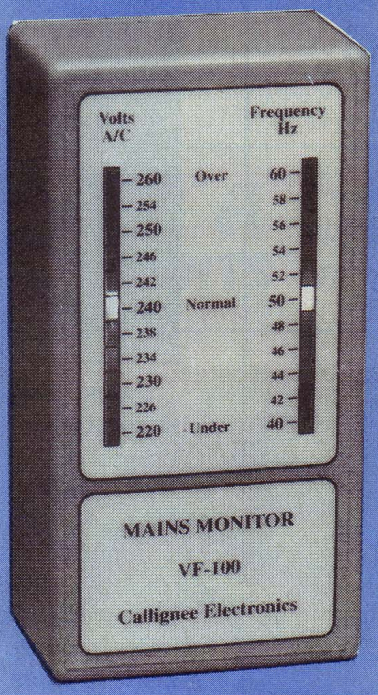
The PalmScope 320 digital storage oscilloscope, designed and manufactured by Escort Instruments, is unlike other portable, integrated test instrument packages. The four auto-ranging instruments integrated into Escort's PalmScope 320 are: a 2-channel 20MHz digital storage scope; a 3-3/4 digit true-RMS digital multimeter (with AC/DC amps); a 7-digit, 20MHz frequency/period counter; and an 8-channel, 20MHz logic analyser.

The unit has specifications normally only found on dedicated bench top instruments. Some of these specifications include: 2K (1920 point) deep DSO memory; accuracy of 10ppm on the frequency counter; and an 8-channel logic analyser with both timing and state signal displays.

The PalmScope 320 is supplied complete with oscilloscope and multimeter probes, protective rubber holster, AC power pack, nicad rechargeable battery pack and a slim briefcase style carrying case. Options include an RS-232 interface cable, PC data transfer software and logic analyser probes.

For further information contact Emona Instruments, 86 Parramatta Road, Camperdown, NSW 2050. Phone (02) 519 3933. Fax (02) 550 1378.

VF-100 true-RMS mains monitor



For country people who generate their own electricity, whether by wind, solar or water power, Callignee Electronics has released the VF-100 mains monitor. The device is intended to prevent damage to sensitive equipment by verifying that generators are running at the correct speed and that battery inverters are adjusted correctly.

The unit measures true RMS voltage and cycles per second of the mains supply and displays the results on a LED bargraph. The VF-100 is also widely used by electricians and generator mechanics who service and install alternative power systems.

The price is $170 plus tax where applicable. Write for a pamphlet to Callignee Electronics, PO Box 483, Traralgon, Vic 3844; or phone (051) 955 503.

New A/D converter board from Procon

Procon Technology has released an externally mounted analog input board that extends its range of input/output boards manufactured in Australia. The ADC-808 provides eight analog inputs with 8-bit resolution and is available with 0-10V or 0-20mA input ranges. Other configurations are available on request.

An industrial version, the ADC-808/I, is also available with 500V isolation between each analog input, detachable screw terminals for easy installation and extended supply voltage range. The board measures 240 x 100mm and is capable of being DIN rail mounted.

A single IBM-PC interface card (PB-BD-IO) is available that plugs into an 8-bit card slot and connects to 15 ADC-808 boards. This offers up to 120 analog inputs. Alternatively, the boards may be connected to any standard bidirectional parallel printer port (available on most notebook and industrial computers) to provide up to 56 analog inputs. Different configurations of analog and digital input/output cards are possible with this inter-

face. Typical applications include process monitoring and control, energy management, home automation, security systems and industrial control.

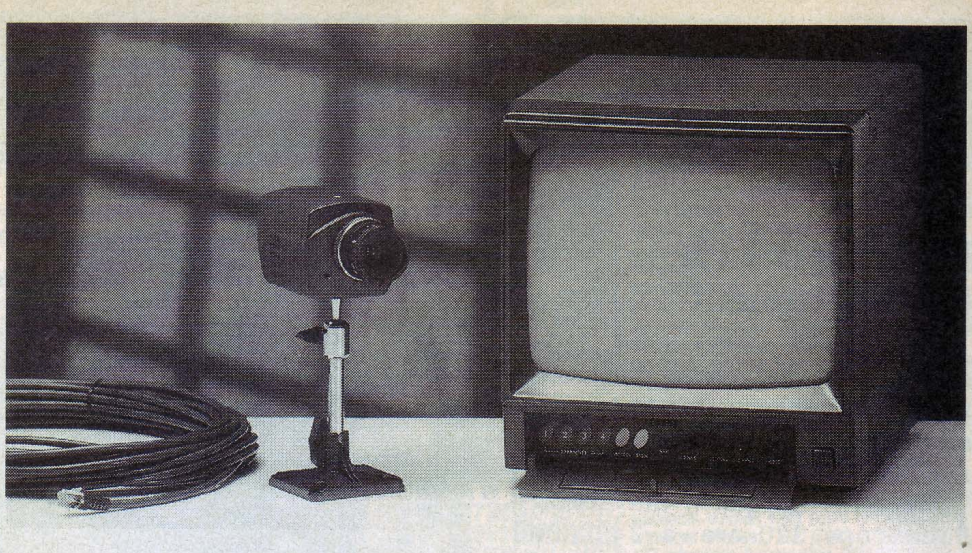
Other boards are available in the range, including opto-isolated digital input and relay output boards. All are available with the industrial option.

All boards come with example software for programming from most languages and are compatible with the Programmable Logic Control language developed by Procon Technology.

For further details, contact Procon Technology, PO Box 655, Mount Waverley, Vic 3149. Phone (03) 807 5660. Fax (03) 807 8220.

CCTV observation systems

The OLS-100 with 10-inch screen and the OLS-120 with 12-inch screen are complete plug-in ready-to-use observation systems. They are Intel microprocessor controlled and feature automatic period-adjustable sequential camera switching, 2-way monitor/camera audio communication, sensor inputs and VCR output.



Each package includes a combination monitor/intercom and automatic 4-channel switcher, a 400-line 0.2 Lux CCD camera with 12mm lens, a camera stand and a 20 metre camera cable. To use, simply mount the camera, connect the monitor and switch on. Camera cable length may be extended using a plug-in coupler. The single lightweight multi-core 5mm diameter camera cable is installed with the aid of adhesive cable holders.

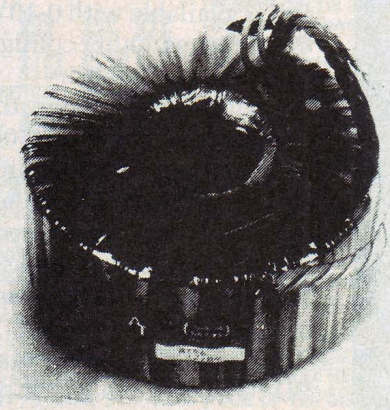
Each unit supports up to four cameras and four sensors. Three styles of intercom camera units are available: conventional C mount, eyeball and flat, with wide angle lenses. In addition, tiny pinhole modules which can see through a 2mm hole are available for concealed applications.

Sensor inputs on each camera allow monitoring of camera locations using PIR or other devices. If a sensor is tripped, an alarm sounds and the image from the camera in the violated area is automatically displayed on screen.

Packaged sets from $699 including

ANTRIM

TOROIDAL TRANSFORMERS



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- Standard range 15VA to 2kVA.
- Large ex-stock quantities available.
- Competitive pricing available for OEMs & resellers.
- Simply the best transformers all round.

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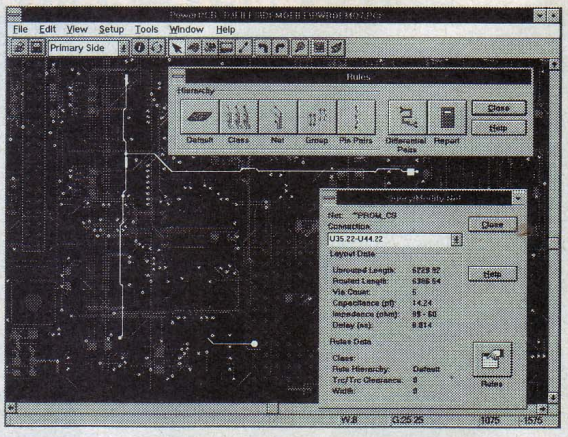
40 Leighton Place, Hornsby NSW 2077
Phone (02) 476 5854 Fax (02) 476 3231

PowerPCB CAD package



PADS Software Inc has announced PowerPCB for PC board design, intended for users who work with UNIX or Windows. This has a number of advanced features including a shape-based PCB editor which allows freedom from grid restraint during placement, routing and editing, a dynamic route editor which has semi-automatic 45° routing to avoid obstacles or move them out of the way, plus conditional rules and design rules hierarchy.

At the same time as the release, special offers are being made to users of Protel and P-CAD to enable them to buy PADS software.

For further information, contact the Australian distributors, GEC Electronics Division, Unit 1, 38 South St, Rydalmere, NSW 2116. Phone (02) 638 1888.

tax are available from Allthings Sales & Services, PO Box 25, Northlands, WA 6021. Phone (09) 349 9413.

High capacity tape backup system

Hewlett-Packard has announced the release of its Jumbo 1400 tape backup system which provides 680 megabytes of storage on a single mini-cartridge or 1.36Gb using data compression.

The Jumbo 1400 is an internal drive that installs in a normal 3.5-inch or 5.25-inch half-height bay. It can interface to a PC's floppy disc controller but the system also includes a separate high speed controller that takes advantage of the drive's maximum transfer rate of 2Mb/s and provides backup at up to 15Mb/minute. The system includes a formatted mini-cartridge and backup programs for Windows and DOS.

Australian pricing is expected to be under $700. For further information, contact Hewlett-Packard by phoning 131 347.

New Yokogawa digital scope

With unique 10-bit, 100Ms/s A/D converters in each channel and a 100K word length, the new DL4100 digital oscilloscope from Yokogawa gives four times better vertical resolution and 100 times better horizontal resolution than scopes with conventional 8-bit A/D converters and 1K word memories. This allows accurate measurements to be made on complicated waveforms.

The DL4100 4-channel 150MHz digital storage oscilloscope is designed specifically for use where accurate and reliable measurements are to be made on complicated waveforms, such as TV signals, AM signals and noise signals.

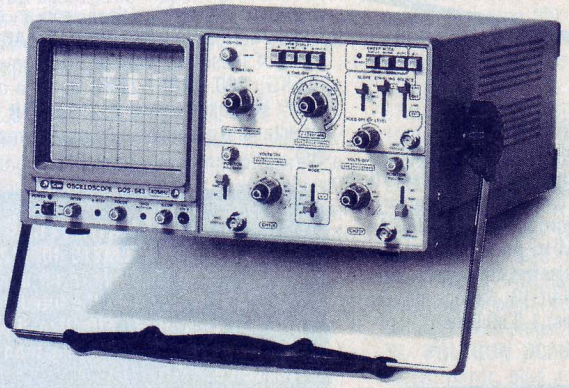
Greater measurement accuracy is also achieved in multi-channel measurements by virtue of the DL4100's split display mode. This allows a full scale to be applied to each signal in a

separate screen area, rather than the amplitude of the trace having to be reduced to view each input signal, and thus incurring an increase in errors. Also ensuring high accuracy measurements at all times, the DL4100 automatic self-calibration feature initiates every 30 seconds or when settings such as time/div are changed.

When the DL4100 is to be used for advanced analysis or as part of a larger measurement system, or if hard copy plots are required, connection can be made via a built-in GPIB interface.

For further information, contact Yokogawa Australia Pty Ltd, 25-27 Paul St North, North Ryde, NSW 2113. Phone (02) 805 0699. SC

50MHz
Only $1,076*



GW Instruments is one of only 2 Taiwanese manufacturers of test and measuring instruments to be certified to the ISO9002 Quality Standard. This certification is your guarantee of a quality, yet most affordable 50MHz, 2CH scope available.

Features of the GW GOS-653 Oscilloscope include:

- *50MHz, 2 Channels*
- *Maximum Sensitivity of 1mV/DIV*
- *Auto Trigger Level Lock uses a special pk-pk detector*
- *Alternate Trigger Mode to trigger asynchronous signals*
- *Variable Hold-Off ensures easy viewing of complex signals*
- *DC Trigger coupling for viewing low frequency signals*
- *Signal delay line to display leading edge*
- *12kV acceleration Voltage for bright display*
- *Channel 1 signal output can be connected to other instruments*

** Price quoted includes probes and excludes sales tax*

EMONA INSTRUMENTS

Available from Emona Offices Australia Wide:

***NSW** (02) 519 3933 **QLD** (07) 397 7427*
***VIC** (03) 889 0427 **WA** (09) 361 4200*

Also available from dealers around Australia.

KITS & BITS

OATLEY ELECTRONICS
PO Box 89, Oatley, NSW 2223
Phone (02) 579 4985 Fax (02) 570 7910
Bankcard, Master Card, Visa Card & Amex accepted with phone & fax orders. P & P for most mixed orders: Aust. $6; NZ (airmail) $10.

MINIATURE FM TRANSMITTER

Not a kit, but a very small ready made self contained FM transmitter enclosed in a small black metal case. It is powered by a single small 1.5V silver oxide battery, and has an inbuilt electret microphone. SPECIFICATIONS: Tuning range: 88-108MHz, Antenna: wire antenna - attached, Microphone: electret condenser, Battery: one 1.5V silver oxide LR44/G13, Battery life: 60 hours, Weight: 15g, Dimensions: 1.3"x0.9"x0.4".

$32

IR REMOTE SWITCH KIT

Consists of a PCB and all on board components kit for an IR receiver with a toggle output, and a brand new commercial ready made slimline IR remote control transmitter, which was designed for a CD player. Simply press any button on the IR transmitter to toggle the output on the receiver: the system has up to 20M range and will also work from most other IR remote controls! Receiver uses an IC "front end", has a toggle output, operates from 8-15V DC, and will drive a relay. Transmitter operates from two "AAA" batteries (not supplied). Unbelievable pricing:

$18

For the slimline IR remote control transmitter and a kit for the IR receiver. Suitable 12V/8A relay with 4KV isolation: $3; 12V DC plugpack: $10.

ARGON LASER

Large water cooled ARGON laser that outputs 7W of blue-green, or 1W of red via an inbuilt dye laser. Originally intended for medical use, and is supplied with but can be easily separated. Has only done 200 hours of operation!

$12000

MAINS LASER SPECIAL

Includes a compact potted US made power supply which can be powered from 110/220-240V AC, a 2-3mW He-Ne tube, a ballast resistor and instructions. The power supply requires 4-6V @ 2mA DC enable to run. Brand new components. Giveaway price:

$65

REEL TO REEL TAPES

New studio quality 13cm-5" "Agfa" (German) 1/4" reel to reel tapes in original box, 180m-600ft: $8 Ea.

OPTICS

BEAM SPLITTER for 633nm: $45. **PRECISION FRONT SURFACE ALUMINIUM MIRRORS** 200 x 15 x 3mm: $3 50 x 72 x 3mm: $3. **LINE GENERATING OPTIC** Makes a line out of a laser beam: $5 **LASER DIODE COLLIMATING LENS:** $4. **PORRO 90 deg. PRISM** Makes a rainbow from white light: $10. **PRECISION ROTATING MIRROR ASSEMBLY** As used in levelling equipment, needs small motor/belt, plus a laser beam, will draw a line right around a room (360deg.) with a laser beam: $45. **LARGE LENS ASSEMBLY** Tominon 230mm f4.5 1.7KG symmetrical lens, add an eyepiece ($4) to make a telescope: $40. **PAIR OF LARGE LENSES** Two pairs of these are used in the above Tominon lens (0.6KG): $20. **LARGE LENS** Out of a night viewer, can easily be pulled apart: $18. **ARGON MIRRORS** High reflector and output coupler used to make a Argon tube: $50.

DOT MATRIX LCDs

Brand new Hitachi LM215 400x128 dot matrix Liquid Crystal Displays in an attractive housing. These have driver ICs fitted but require an external controller. Effective display size is 65x235mm. Available at less than 10% of their real value:

$25 Ea. or 3 for $60

27 MHz TRANSMITTERS

These new Australian made transmitters are assembled (PCB and components) and tested. They are Xtal locked on 26.995 MHz and were originally intended for transmitting digital information. Their discrete component design employs many components, including 5 transistors and 8 inductors: Circuit provided. A heatsink is provided for the output device. Power output depends on supply voltage and varies from 100mW to a few watts, when operated from 3-12V DC. These are sold for parts/experimentation/educational purposes, and should not be connected to an antenna as licensing may be required:

$7 Ea. or 4 for $20

$215 CCD VIDEO SECURITY SYSTEM

Monochrome CCD Camera which is totally assembled on a small PCB and includes an auto iris lens. It can work with illumination of as little as 0.1 Lux and it is IR responsive. This new model camera is about 1/2 the size of the unit we previously supplied. It is slightly bigger than a box of matches! Can be used in total darkness with Infra Red illumination. NEW LOW PRICE:

$180

With every camera purchased we can supply a used but tested and guaranteed 12V DC operated green computer monitor. We can also supply a simple kit to convert these monitors to accept the signal from the CCD camera: Monitor $25, conversion kit $10.

A COMPLETE 12V CCD VIDEO SECURITY SYSTEM FOR $21

PRINTER MECHANISMS

Brand new Epson dot matrix printer mechanisms. Overall dimensions are 150x105x70mm. These are complete units and contain many useful parts: 12V DC motor (50mm long-30mm diam.) with built in tachometer, gears, solenoid, magnet, reed switch, dot matrix print head etc.:

$12

VISIBLE LASER DIODE KIT

A 5mW/670nm visible laser diode plus a collimating lens, plus a housing, plus an APC driver kit (Sept. 94 EA) UNBELIEVABLE PRICE:

$ 35

The same kit is also available with a 3mW / 650nM laser diode:

$60

CD MECHANISMS

Used compact disc player mechanisms. Include IR laser diode, optics, small conventional DC motor, gears, stepping motor, magnets etc. Great for model railway hobbyists: the motor - gear assy. produces a linear movement of approx. 60mm. The whole assembly is priced at less than the value of the collimating lens, which is easy to remove: **$6**

We also have some similar CD assemblies that have linear motors. Used CD mechanisms with linear motors: $4

WELLER SOLDERING IRON TIPS

New soldering iron for low voltage Weller soldering stations and mains operated Weller irons. Mixed popular sizes and temperatures. Specify mains or soldering station type: 5 for $10.

LOW COST 1-2 CHANNEL UHF REMOTE CONTROL

Single channel 304MHz UHF remote control with over 1/2 million code combinations which also makes provision for a second channel expansion. The low cost design includes a complete compact keyring transmitter kit, which includes a case and battery, and a PCB and components kit for the receiver that has 2A relay contact output! Tx kit $10, Rx kit $20; additional components to convert the receiver to 2 channel operation (extra decoder IC and relay) $6.

INCREDIBLE PRICES:
COMPLETE 1 CHANNEL TX-RX KIT: $30
COMPLETE 2 CHANNEL TX-RX KIT: $36
ADDITIONAL TRANSMITTERS: $10

IMAGE INTENSIFIER TUBES

Used but in excellent condition second generation image intensifier tubes. Can be used to make a small and very sensitive scope that can produce high resolution pictures in very low illumination. US made tubes that produce superior results!

$650

We should have a complete kit of parts for a small scope available at the time of the publication of this advertisement: "Ring".

FIBRE OPTIC TUBES

These US made tubes are from used equipment but in excellent condition. Have 25/40mm diameter, fibre-optically coupled input and output windows. The 25mm tube has an overall diameter of 57mm and is 60mm long, the 40mm tube has an overall diameter of 80mm and is 92mm long. The gain of these is such that they would produce a good image in approximately 1/2 moon illumination, when used with suitable "fast" lens, but they can also be IR assisted to see in total darkness. Our HIGH POWER LED IR ILLUMINATOR kit, and the IR filter are both suitable for use with these tubes. The superior resolution of these tubes would make them suitable for low light video preamplifiers, wild life observation, and astronomical use. Each of the tubes is supplied with an 9V-EHT power supply kit. INCREDIBLE PRICES:

$120 for the 25mm intensifier tube and supply kit.
$180 for the 40mm intensifier tube and supply kit.

We also have a good supply of the same tubes that may have a blemish which is not in the central viewing

area!: !!ON SPECIAL!! $50 for a blemished 25 or 40mm (specify preference) image intensifier tube and supply kit. Matching good quality eyepiece lens only, $2 Extra! That's almost a complete night viewer kit for **$52.**

BLEMISHED 3 STAGE TUBES

We have accumulated a good number of 40mm three stage fibre optically coupled 3 stage image intensifiers that have minor blemishes: similar to above but three tubes are supplied already bonded together: Extremely high gain!! Each of these tubes will be supplied with the power supply components only. See SC Sept. 94.

$200

For the 3 stage 40mm tube, supply kit. We can also supply the full SC Sept. 94 Magazine: $5

VISIBLE LASER DIODE MODULES

Industrial quality 5mW/670nm laser diode modules. Overall dimensions: 11mm diameter by 40mm long. Have APC driver built in and need approximately 50mA from 3-6V supply.

$60

VIDEO TRANSMITTERS

Low power PAL standard UHF TV transmitters. Have audio and video inputs with adjustable levels, a power switch, and a power input socket: 10-14V DC/10mA operation. Enclosed in a small metal box with an attached telescopic antenna. Range is up to 10m with the telescopic antenna supplied, but can be increased to approximately 30m by the use of a small directional UHF antenna. INCREDIBLE PRICING:

$25

12V FANS

Brand new 80mm 12V-1.6W DC fans. These are IC controlled and have four different approval stamps:

$10 Ea. or 5 For $40.

TDA ICs/TRANSFORMERS

We have a limited stock of some 20 Watt TDA1520 HI-FI quality monolithic power amplifier ICs - less than 0.01% THD and TIM distortion, at 10W RMS output! With the transformer we supply we guarantee an output of greater than 20W RMS per channel into an 8ohm load, with both channels driven. We supply a far over-rated 240V-28V/80W transformer, two TDA1520 ICs, and two suitable PCBs which also include an optional preamplifier section (only one additional IC), and a circuit and layout diagram. The combination can be used as a high quality HI-FI Stereo/Guitar/PA amplifier. Only a handful of additional components are required to complete this excellent stereo/twin amplifier! Incredible pricing:

$25

For one 240V-28V (80W!) transformer, two TDA1520 monolithic HI-FI amplifier ICs, two PCBs to suit, circuit diagram/layout. Some additional components and a heatsink are required.

RUBY LASER HEADS

These complete and functional heads include a flash tube, mirrors, and 4" ruby rod! Produce a high intensity visible red beam! We should have suitable circuits - components to drive these available. Dangerous units with restricted sales. Limited quantity.

$695

TWO STEPPER MOTORS PLUS A DRIVER KIT

This kit will drive two stepper motors: 4, 5, 6 or 8 eight wire stepper motors from an IBM computer parallel port: motors require separate power supply. A detailed manual on the COMPUTER CONTROL OF MOTORS plus circuit diagrams/descriptions are provided. We also provide the necessary software on a 5.25" disc. Great "low cost" educational kit: We provide the kit, manual, disc, plus TWO 5V/6 WIRE/7.5 Deg. STEPPER MOTORS FOR A SPECIAL PRICE OF: **$42**

BIGGER LASER

We have a good, but LIMITED QUANTITY of some "as new" red 6mW+ laser heads that were removed from new equipment. Head dimensions: 45mm diameter by 380mm long. With each of the heads we will include our 12V Universal Laser power supply. BARGAIN AT:

$170 6mW+ head/supply. ITEM No. 0225B.

We can also supply a 240V-12V/4A-5V/4A switched mode power supply to suit for $30.

12V-2.5 WATT SOLAR PANEL KITS

These US made amophorous glass solar panels only need terminating and weather proofing. We provide terminating clips and a slightly larger sheet of glass. The terminated panel is glued to the backing glass, around the edges only. To make the final weatherproof panel look very attractive some inexpensive plastic "L" angle could also be glued to the edges with some silicone. Very easy to make. Dimensions: 305x228mm, Vo-c: 18-20V, Is-c: 250mA. SPECIAL REDUCED PRICE:

$20 Ea. or 4 for $60

Each panel is provided with a sheet of backing glass, terminating clips, isolating diode and instructions. A very efficient switching regulator kit is available: suits 12-24V batteries, 0.1-16A panels, $27. Also available is a simple and efficient shunt regulator kit, $5.

SOLID STATE "PELTIER EFFECT" COOLER-HEATER

These are the major parts needed to make a solid state thermoelectric cooler-heater. We can provide a large 12V-4.5A Peltier effect semiconductor, two thermal cutout switches, and a 12V DC fan for a total price of:

$45

We include a basic diagram/circuit showing how to make a small refrigerator-heater. The major additional items required will be an insulated container such as an old "Esky", two heatsinks, and a small block of aluminium. 12V-4.5A Peltier device only $35.

VEHICLE COMPUTERS

Originally designed for bicycles, but these suit any moving vehicle that has a rotating wheel! A nine function computer with speed, average speed, maximum speed, distance, odometer, timer, scan, freeze frame memory, and a clock. Its microprocessor based circuitry can be adapted to work with almost any wheel diameter. Simply divide the wheel diameter in millimetres by 6.8232, and program the resultant figure into the computer.

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MORE KITS-ITEMS

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VINTAGE RADIO

By JOHN HILL

Fault finding – there's always something different

Vintage radio receivers can develop some very unusual faults. Here's what it took to bring two old receivers back to life again.

Having done numerous vintage radio repairs during the past 10 years, I have encountered a wide range of faults and problems. After a while, repairs become fairly routine and it usually doesn't take long to diagnose a fault and repair it.

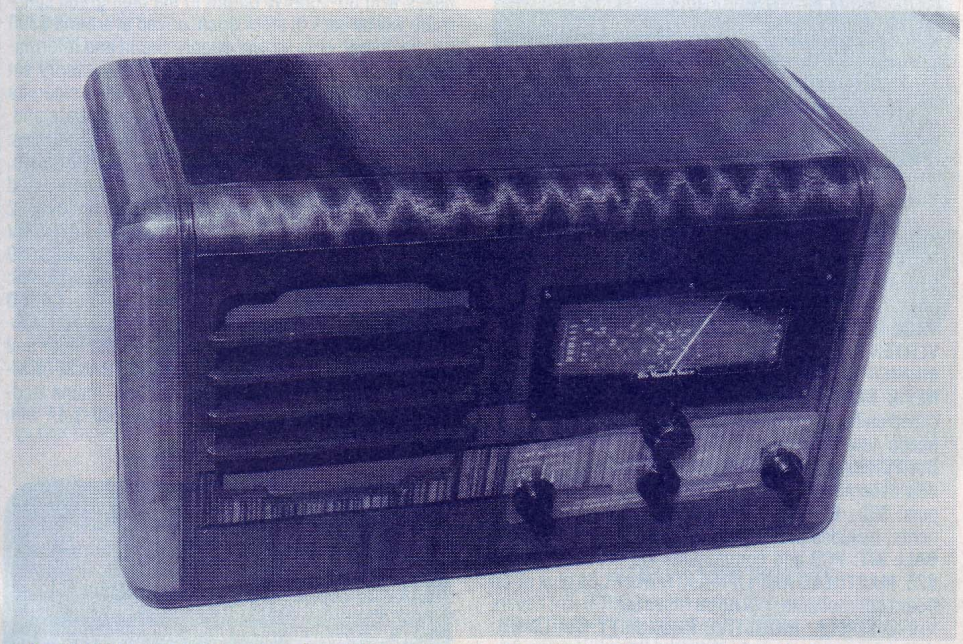
However, this is not always the case and whenever I come across anything unusual, I like to pass the details on so that others can benefit from my experiences.

Not all the repairs I do are for myself and I frequently become involved in the problems of other collectors. This often means having to solve some nasty problem or doing a full restoration for someone who has no idea of what is involved. They wrongly believe that I can fix anything, have all the necessary spare parts and that the whole job takes about 20 minutes.

In the following stories, one receiver had some hard to find faults, while the other is interesting because of the extent of damage the set had sustained.

The HMV table model

The first headache was an early post-war dual-wave 5-valve HMV table model with a timber cabinet. On removing the chassis, it was evident that someone had already replaced most of the capacitors, including the electrolytics, but a couple of the old original paper capacitors still remained. These were replaced before any serious attempt was made to see why the set was not working.



The HMV receiver was an early post-war 5-valve table model in a timber cabinet. Some misplaced wiring, a short circuit in some shielded wire & a missing capacitor caused quite a few headaches.

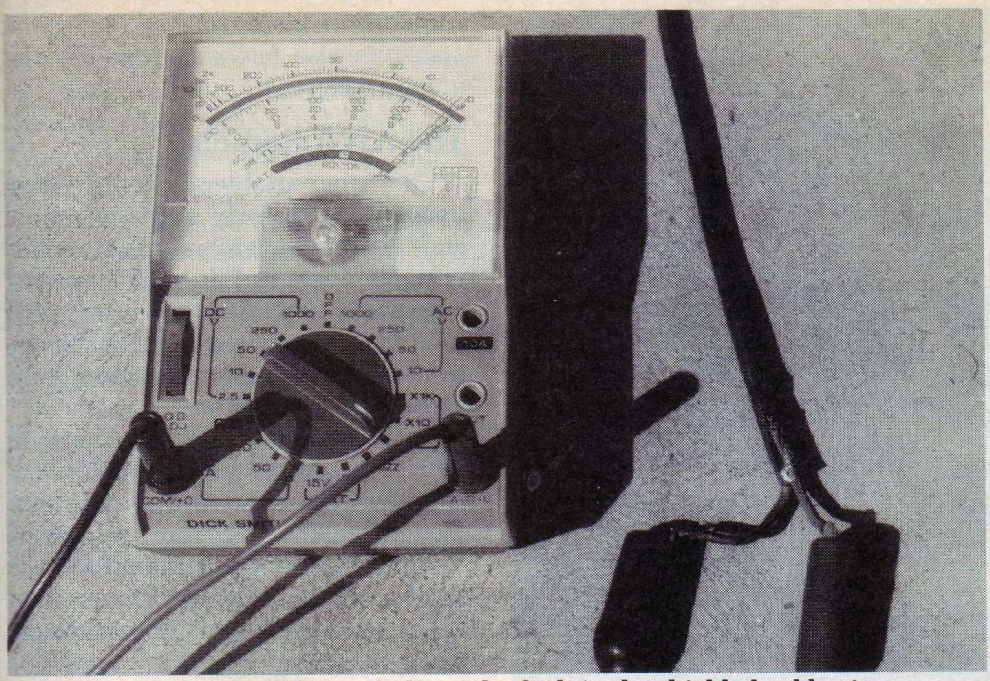
The usual routine continuity checks were also made on the aerial and oscillator coils, intermediate frequency (IF) transformers, the resistors, output transformer and the field coil. All passed OK. In addition, a valve tester revealed that all the valves were in excellent condition. But despite all these favourable indications, the receiver was quite mute.

Now I have a handy little gadget called an "astable multivibrator". This is a simple 2-transistor signal generator that outputs a 2kHz tone. The signal generator can be used to inject an audible signal into either the radio or audio frequency circuits of a receiver so as to test whether or not a particular stage is working (see SILICON CHIP, August 1992).

Placing the signal generator's probe onto the control grid of the output valve produced a beep from the loudspeaker. That immediately cleared the output stage. Similarly, connecting the probe to the grid of the output driver (or first audio valve) produced a much louder beep, indicating that this stage was also alive and well.

By contrast, moving the probe back to the control grid of the IF amplifier valve resulted in no sound whatsoever through the speaker. So the fault lay somewhere between this stage and the next.

But although a signal generator can



An ohmmeter was used to track down the fault in the shielded cable. As can be seen, it indicates a short between the inner lead & the shielded cable. It's no wonder that the receiver was mute.

This photo shows the troublesome shielded wire in the old HMV radio. The short circuit was at the solder joint where the heat of the soldering iron had damaged the rubber insulation of the inner lead. This problem has been encountered before in other old receivers, so it was not an isolated incident.

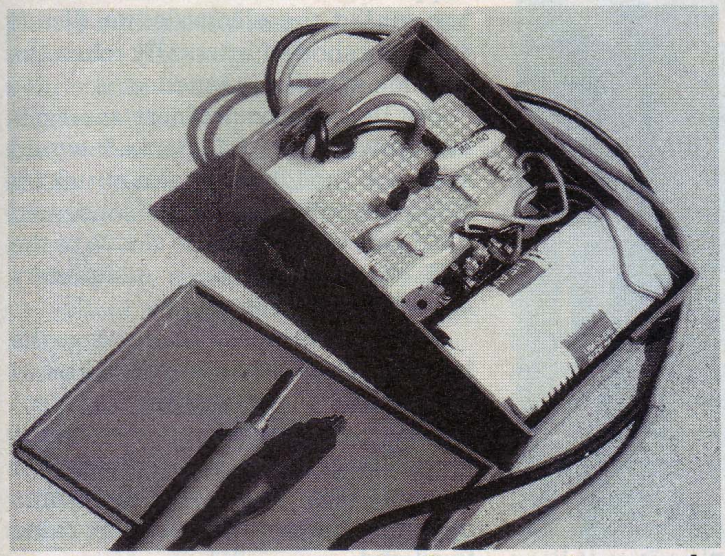
help locate which section is at fault, it only narrows the field down a little. There were a lot of components to check out between the grid of the IF valve and the grid of the first audio valve in order to find out which one is faulty, disconnected, shorted, or whatever.

By using a pair of high-impedance headphones in conjunction with a small mica capacitor (to block high DC voltages) and a signal diode (for detection), it was noted that a local radio station could be heard when this simple test equipment was connected to the plate of the IF amplifier valve. (Warning: a valve plate operates at high voltage. Do not try this unless you know exactly what you are doing). So where the signal injector implied that this valve may not have been working, in actual fact it was and the trouble spot was further on down the line.

The problem was obviously between the IF valve output and the control grid of the first audio valve. As the second IF transformer had checked out OK, then perhaps there was something wrong with the detector circuit or the volume control. The volume control was removed, checked and found to be perfectly OK. It was therefore reinstalled in the chassis.

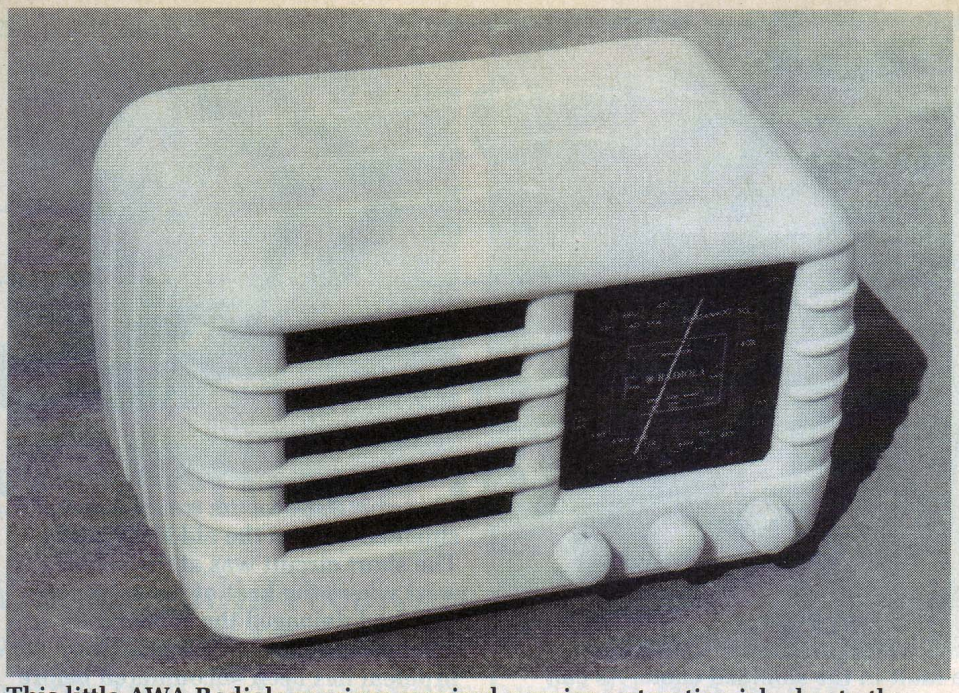
This HMV receiver has two shielded leads that bring audio signals from the detector and the pick-up socket to the volume control, after which they are fed to the control grid of the first audio valve. It occurred to me that I had a similar problem once before, which turned out to be a short circuit in a shielded cable.

A quick investigation revealed a similar fault in this unit – the inner wire from the pick-up socket was found to be shorting where a wire had been soldered to the shielding to make an earth connection. Apparently, the heat of the soldering iron had damaged the rubber insulation between



This home-made 2-transistor signal generator is powered by two AA cells. It produces a 2kHz signal that can be injected into the RF & audio stages in a receiver.

The signal generator circuit was housed in an old Tandy burglar alarm case. It is a very handy device when it comes to troubleshooting old radio receivers.



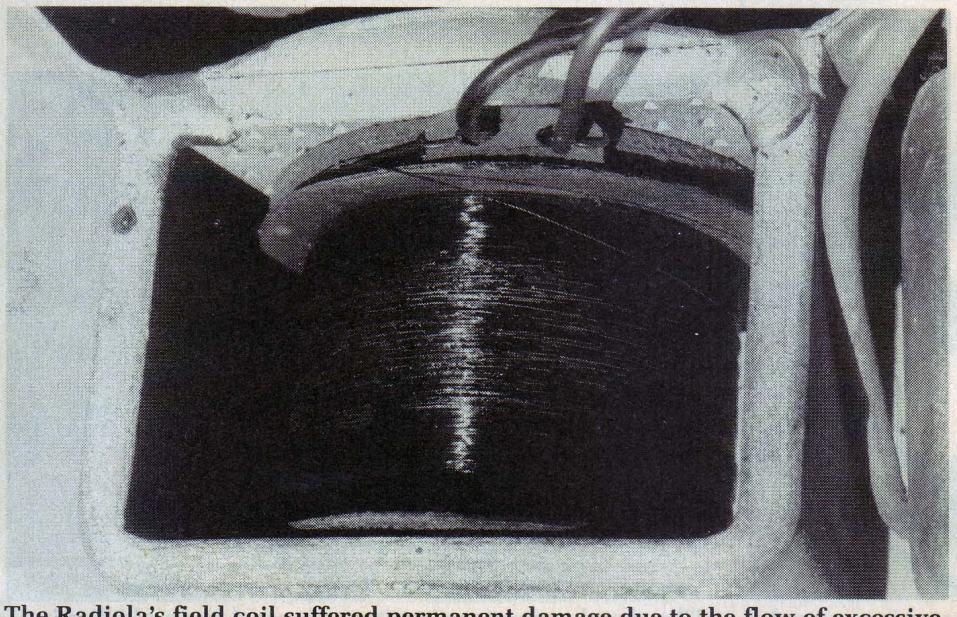
This little AWA Radiola receiver required a major restoration job, due to the failure of the set's high tension supply. In fact, the costs exceeded the value of the old receiver but the owner insisted that the job be done.

the inner wire and the shield, which eventually shorted and muted the receiver.

The shielded lead probably gave no trouble until it was disturbed and that most likely happened when the capacitors were replaced. After replacing the shielded cable, one would expect everything to work OK but there were still problems!

Who ever had previously replaced the capacitors had not reconnected two of them correctly to the volume control. Although the receiver was partly working, there were audio problems and the shortwave section was only just functioning.

Not having a circuit diagram, I did the next best thing. I borrowed a similar model HMV from a friend and used it to trace the muddled connections. A bit of a swap around at the volume control and all was well in that department. The shortwave reception was restored by adding a capacitor that had been previously removed and not replaced. After realignment, the receiver then worked normally.



The Radiola's field coil suffered permanent damage due to the flow of excessive high tension current. Note that the enamel insulation has been burnt off the wire. The paper wrapping on the outside was charred to a crisp.

Taking on an unfinished repair that someone else has abandoned is not always easy!

The AWA Radiola

The other problem receiver was, once again, an early post war model and it had more faults than you could possibly imagine. The main problems were: a broken dial glass, an open field coil, a burnt out rectifier valve, defective capacitors and a couple of well-cooked resistors.

As it was an old AWA receiver with its original black moulded paper capacitors, it was not unreasonable to assume that they were the cause of the trouble. This set had suffered a major breakdown and it would require a lot of time and spare parts to get it working again.

The most likely scenario regarding the set's demise is as follows. A shorted high tension component (possibly a paper capacitor or an electrolytic) caused a considerable increase in high tension current. As the receiver used an electrodynamic loudspeaker, the increased high tension current had no option but to flow through the field coil, which caused considerable overheating.

In fact, the field coil became so hot it burnt the enamel insulation off the wire and charred the paper wrapping around the coil to a crisp. Only a few fragments of blackened paper remained.

A short circuit of this nature also usually results in the rectifier plates glowing red hot because of the high current demands and that no doubt happened in this case. This overheating caused the electrodes to distort and they shorted internally when the cathode and plates touched.

But this was no ordinary short circuit between valve elements. It would appear as though an arc was struck (as in arc welding) and this arc continued until part of the cathode sleeve of the 6X5 rectifier had been completely zapped away – see photo.

While all this was happening, the two 100Ω half watt resistors between the rectifier plates and the high tension winding on the power transformer were severely overloaded. It was only when these resistors became open that the fireworks display came to an end.

Naturally such abnormal demands on the power transformer caused it to

overheat too. There were several dobs of black pitch stuck to the bottom of the cabinet to verify that the transformer had indeed become very hot at some time in the past.

Readers may be able to think up other possible reasons for the high tension failure. While the scenario I have presented is possible and makes interesting speculation, it may have happened some other way!

No doubt the receiver was unattended at the time of failure. One assumes that such a performance would not have gone unnoticed and if someone had been nearby, they would have switched the set off.

Generally speaking, a little plastic-cased late 1940s receiver is not a valuable item but the owner was insistent that it be fixed. He liked the set and wanted it going again. A quick check in my spare parts locker revealed that there was a spare dial glass; so work began.

The electrodynamic loudspeaker was replaced with a permag type from a later model Radiola. Fortunately, that meant being able to use the same mounting screws and all the holes in the speaker baffle were in the right places.

When restoring one of these AWA receivers, it is a good idea to glue the replacement speaker cloth to the cabinet rather than in its original position on the front of the loudspeaker baffle. By doing this, it makes the speaker much easier to work on next time and it can be readily removed without having to first remove the speaker cloth.

The overcooked field coil was replaced with a 20W resistor of similar resistance. This substitution produced a little hum in the speaker but it was not objectionable by any means. While a resistor and choke would have given better results, there is little room to mount such things underneath the chassis.

Naturally, all the defective paper capacitors were replaced, as were the electrolytics and a couple of valves, including the burnt-out rectifier.

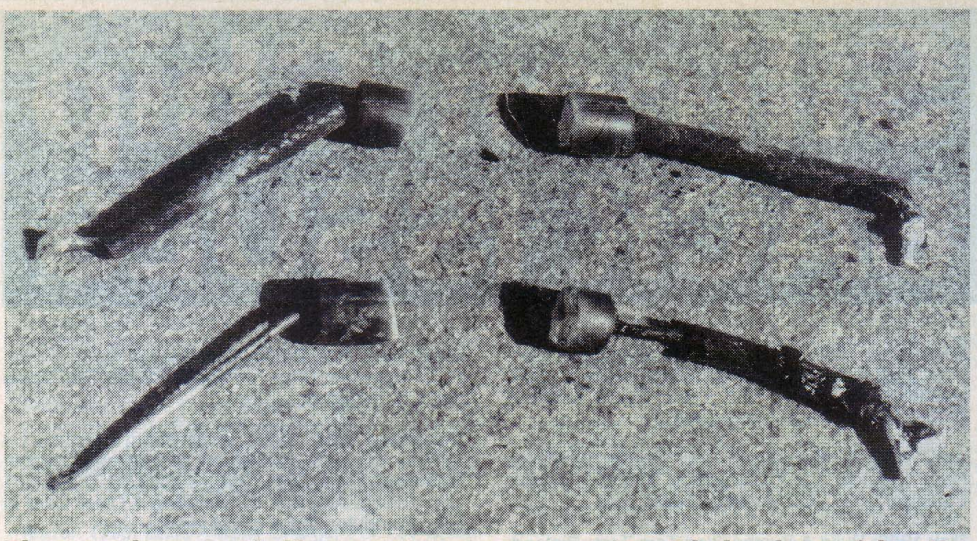
As luck would have it, the power transformer appeared to have been unaffected by the mishap. It had lost a little pitch but the windings were intact and voltages normal. Prolonged use over several hours revealed no signs of overheating and it seemed that no real damage had been done.

The fact that the power transformer had survived so well can probably be attributed to the 100Ω half-watt resistors in the plate leads of the rectifier valve. While not fitted for this reason – their job is to limit the peak current through the rectifier on each conduction cycle – they did act like slow blow fuses (very slow blow fuses!) and eventually cut the circuit. Had they blown earlier, they may have prevented other damage.

However, resistors are not fuses and, even when severely overloaded, they will still pass current for quite a while until they finally breakdown. Unfortunately, other components were being damaged or destroyed in the meantime. In fact, some restorers fit fuses into the high tension circuits for this very reason.

In the end, the amount of time involved to fix the little Radiola was considerable and the repair costs exceeded the value of the radio. But that wasn't my concern; the owner wanted it fixed and that's all there was to it.

To summarise, repairing old valve radios can be both interesting and frustrating – depending on the nature of the problem. No matter how many repairs you may have done, there is always the possibility of finding something new and different. Sometimes fault finding can be a baffling experience but with a little perseverance, most problems can be solved. **SC**



These two burnt-out half-watt resistors were in series with the plates of the 6X5 rectifier & the high-tension winding on the power transformer. They have been totally destroyed, leaving only the ends and a powdery white centre piece. Their eventual failure probably saved the power transformer from destruction.

This close-up view shows the effects of the overload within the rectifier valve. Arcing within the valve has completely removed the cathode sleeve, leaving the heater element clearly visible between the two plates.

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September 1992: Multi-Sector Home Burglar Alarm; Heavy-Duty 5A Drill speed Controller (see errata Nov. 1992); General-Purpose 3½-Digit LCD Panel Meter; Track Tester For Model Railroads; Build A Relative Field Strength Meter.

October 1992: 2kW 24VDC To 240VAC Sinewave Inverter; Multi-Sector Home Burglar Alarm, Pt.2; Mini Amplifier For Personal Stereos; Electronically Regulated Lead-Acid Battery Charger.

January 1993: Peerless PSK60/2 2-Way Hifi Loudspeakers; Flea-Power AM Radio Transmitter; High Intensity LED Flasher For Bicycles; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.4; Speed Controller For Electric Models, Pt.3.

February 1993: Three Simple Projects For Model Railroads; A Low Fuel Indicator For Cars; Audio Level/VU Meter With LED Readout; Build An Electronic Cockroach; MAL-4 Microcontroller Board, Pt.3; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.5.

March 1993: Build A Solar Charger For 12V Batteries; Alarm-Triggered Security Camera; Low-Cost Audio Mixer for Camcorders;A 24-Hour Sidereal Clock For Astronomers.

April 1993: Solar-Powered Electric Fence; Build An Audio Power Meter; Three-Function Home Weather Station; 12VDC To 70VDC Step-Up Voltage Converter; Digital Clock With Battery Back-Up.

May 1993: Nicad Cell Discharger; Build The Woofer Stopper; Remote Volume Control For Hifi Systems, Pt.1; Alphanumeric LCD Demonstration Board; The Microsoft Windows Sound System.

June 1993: Windows-Based Digital Logic Analyser, Pt.1; Build An AM Radio Trainer, Pt.1; Remote Control For The Woofer Stopper; Digital Voltmeter For Cars; Remote Volume Control For Hifi Systems, Pt.2

July 1993: Build a Single Chip Message Recorder; Light Beam Relay Extender; AM Radio Trainer, Pt.2; Windows Based Digital Logic Analyser; Pt.2; Quiz Game Adjudicator; Programming The Motorola 68HC705C8 Microcontroller – Lesson 1; Antenna Tuners – Why They Are Useful.

August 1993: Low-Cost Colour Video Fader; 60-LED Brake Light Array; A Microprocessor-Based Sidereal Clock; The Southern Cross Z80-based Computer; A Look At Satellites & Their Orbits.

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October 1993: Courtesy Light Switch-Off Timer For Cars; Wireless Microphone For Musicians; Stereo Preamplifier With IR Remote Control, Pt.2; Electronic Engine Management, Pt.1; Programming The Motorola 68HC705C8 Microcontroller – Lesson 2; Servicing An R/C Transmitter, Pt.2.

November 1993: Jumbo Digital Clock; High Efficiency Inverter For Fluorescent Tubes; Stereo Preamplifier With IR Remote Control, Pt.3; Siren Sound Generator; Electronic Engine Management, Pt.2; More Experiments For Your Games Card.

December 1993: Remote Controller For Garage Doors; Low-Voltage LED Stroboscope; Low-Cost 25W Amplifier Module; Peripherals For The Southern Cross Computer; Build A 1-Chip Melody Generator; Electronic Engine Management, Pt.3; Index To Volume 6.

January 1994: 3A 40V Adjustable Power Supply; Switching Regulator For Solar Panels; Printer Status Indicator; Mini Drill Speed Controller; Stepper Motor Controller; Active Filter Design For Beginners; Electronic Engine Management, Pt.4.

February 1994: 90-Second Message Recorder; Compact & Efficient 12-240VAC 200W Inverter; Single Chip 0.5W Audio Amplifier; 3A 40V Adjustable Power Supply; Electronic Engine Management, Pt.5; Airbags – How They Work.

March 1994: Intelligent IR Remote Controller; Build A 50W Audio Amplifier Module; Level Crossing Detector For Model Railways; Voice Activated Switch For FM Microphones; Simple LED Chaser; Electronic Engine Management, Pt.6.

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June 1994: 200W/350W Mosfet Amplifier Module; A Coolant Level Alarm For Your Car; An 80-Metre AM/CW Transmitter For Amateurs; Converting Phono Inputs To Line Inputs; A PC-Based Nicad Battery Monitor; Electronic Engine Management, Pt.9

July 1994: SmallTalk – a Tiny Voice Digitiser For The PC; Build A 4-Bay Bow-Tie UHF Antenna; PreChamp 2-Transistor Preamplifier; Steam Train Whistle & Diesel Horn Simulator; Portable 6V SLA Battery Charger; Electronic Engine Management, Pt.10.

August 1994: High-Power Dimmer For Incandescent Lights; Microprocessor-Controlled Morse Keyer; Dual Diversity Tuner For FM Microphones, Pt.1; Build a Nicad Zapper; Simple Crystal Checker; Electronic Engine Management, Pt.11.

September 1994: Automatic Discharger For Nicad Battery Packs; MiniVox Voice Operated Relay; Image Intensified Night Viewer; AM Radio For Aircraft Weather Beacons; Dual Diversity Tuner For FM Microphones, Pt.2; Electronic Engine Management, Pt.12.

October 1994: Dolby Surround Sound – How It Works; Dual Rail Variable Power Supply (±1.25V to ±15V); Talking Headlight Reminder; Electronic Ballast For Fluorescent Lights; Temperature Controlled Soldering Station; Electronic Engine Management, Pt.13.

November 1994: Dry Cell Battery Rejuvenator; A Novel Alphanumeric Clock; 80-Metre DSB Amateur Transmitter; Twin-Cell Nicad Discharger (See May 1993); Anti-Lock Braking Systems: How They Work; How To Plot Patterns Direct To PC Boards.

December 1994: Dolby Pro-Logic Surround Sound Decoder, Pt.1; Easy-To-Build Car Burglar Alarm; Three-Spot Low Distortion Sinewave Oscillator; Clifford – A Pesky Electronic Cricket; Cruise Control – How It Works; Remote Control System for Models, Pt.1; Index to Vol.7.

January 1995: Sun Tracker For Solar Panels; Battery Saver For Torches; Dolby Pro-Logic Surround Sound Decoder, Pt.2; Dual Channel UHF Remote Control; Stereo Microphone Preamplifier; The Latest Trends In Car Sound; Pt1.

February 1995: 50-Watt/Channel Stereo Amplifier Module; Digital Effects Unit For Musicians; 6-Channel Thermometer With LCD Readout; Wide Range Electrostatic Loudspeakers , Pt.1; Oil Change Timer For Cars; The Latest Trends In Car Sound; Pt2; Remote Control System For Models, Pt.2.

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PLEASE NOTE: all issues from November 1987 to August 1988, plus October 1988, November 1988, December 1988, January, February, March and August 1989, May 1990, and November and December 1992 are now sold out. All other issues are presently in stock. For readers wanting articles from sold-out issues, we can supply photostat copies (or tearsheets) at $7.00 per article (includes. p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge.

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Electronic ignition for motorbikes

I would like to update the ignition system on one of my motorbikes. Would it be possible for SILICON CHIP to arrange such a project? A modern compact unit with electronic advance/retard and rev limiter based around an IC (MC3340?) would, I'm sure, be of interest to many car/motorbike racing enthusiasts. My existing unit is now 10 years old. It uses a Hall Effect switch and works well down to 4.5V but relies on mechanical advance/retard and, by modern standards, is fairly bulky, about 120 x 80 x 35mm. An adjustable ignition curve would be an asset, I'm sure. (S. A., Alice Springs, NT)

• While the idea of an ignition system with electronic advance/retard is attractive, it would require a microprocessor or at the very least an EEPROM to store the advance/retard values. This would need to be programmed for each brand and model of bike – a job that is far beyond the capabilities of a small organisation like ours.

The alternative to a microprocessor is to use an analog system which varies the timing in response to engine revs but even this approach is not simple and would not really be satisfactory.

Rev limiting would be much easier and it could be incorporated into a circuit using the MC3334P ignition chip but we feel that it would be no real advantage over the system you already have.

Problems with voice operated relay

I am currently having problems with the above project from the September 1994 issue. The unit just won't function at all, the relay being totally silent and not being activated. I have checked for wiring errors and everything is OK. I have checked out the microphone insert and the relay and both are operative. I have also changed the sensitivity resistor to a variable 250kΩ type and tried many different resistors but still no joy. My other investigations seem to indicate that the op amp is not triggering transistor Q1 to turn it on. Is this the most likely scenario (meaning the IC is cactus?) or is there something else I should do before buying another LM358 chip? (N. P., Ermington, NSW).

• There are a number of tests you can do to diagnose the problem with your project. First, measure the voltage at pin 3 of IC1. It should be about 3-4V, or thereabouts. Pin 1 should have the same value. Pin 6 should be at +2.4V, depending on the input from the plugpack supply.

Second, speak into the microphone while measuring the voltage at pin 5. With no sound, pin 5 will be close to 0V. With speech, it should rise to +3V or more and this should cause pin 7 to go high and switch on Q1.

The most likely faults include cold solder joints, solder shorts between tracks, a faulty or wrongly connected electret microphone and reverse connected diodes.

IR focussing for underwater photos

I do a bit of underwater photography and, as I get older, I have difficulty in focusing, particularly in low light. Most shots are taken with electronic flash, so if I can focus, the shot can be taken.

My latest camera is a Nikon 801s AF with auto-focus macro lens in a housing but it has the same problem. Nikon has an infrared system to focus in the dark on their above-water electronic flashes. Could you please tell me how this works? Would the IR LEDs flash and, if so, at what frequency?

I have an old underwater torch which operates with four "D" cells that could be modified to house the IR diodes and a small amount of circuitry. A normal UW torch helps with focusing but it scares the fish away when you point the rig at them.

I was also wondering if you had any circuits for camera housing leakage detectors in your files. (G. J., Bundall, Qld).

• We do not know how Nikon's IR focusing system works but assume that it would be some sort of range-finder system whereby a narrow IR beam is bounced off the object to be photographed and reflected back to the camera. The beam would be swept through a fairly wide angle until the camera receives a reflection and that would give it the focus distance; at least that's how we think it would be done. We do not have any circuits to detect camera leakage.

Queries on the solar tracker

I have waited for some time for a construction article on a sun tracker. Now you have published one (January 1995) which is very good but I am puzzled by a couple of things about the circuit. Why is pin 4 of the 555 not connected to pin 8 as recommended in the National Semiconductor application notes for this device? Why is there no bypass capacitor on pin 5 for the above reason? I believe it would be normal practice to provide separate gate resistors for the FET switches. Finally, why are there no power supply filter capacitors across the 12V supply?

Other than this I intend to build the unit as soon as I can get my hands on a PC board. (C. W., Leumeah, NSW).

• While National Semiconductor do recommend that pin 4 be tied high, it is not mandatory for it to be so. Nor is

Preamplifier for digital speedo

I would greatly appreciate your help with a digital speedo circuit I am working on. I am using a magnet/inductive pick-up sensor and the Pre-Champ preamplifier (July 1994) to amplify the signals. The Pre-Champ I used is contained in a box connected to the Champ amplifier and the signal tapped off after the Pre-Champ stage and then connected to the counter circuit. When using this setup, the unit works fine but if another Pre-Champ built into the speedo black box is used, all you get is a random display of flickering numbers with no useable (or intelligible) counting taking place.

What can be done to this setup to make it work? (N. P., Ermington, NSW).

• There are two possible problems with using the Pre-Champ preamplifier. The first is that its low frequency response is 3dB at 72Hz and would be rapidly attenuated below that frequency. Since 600RPM corresponds to 10Hz, the bass response should extend down to at least this frequency. To achieve this, increase the 22µF capacitor to 220µF and the 0.1µF input coupling capacitor to 0.33µF or larger.

The second reason why your preamplifier may be playing up is that it is picking up hash from the ignition wiring of your car or from the digital speedo circuit. It may need to be mounted by itself in a shielded metal box and may need more supply decoupling.

a capacitor at pin 5 mandatory. Individual gate resistors for the Mosfets would normally be used in a switching circuit but since the voltages in this circuit are so static, they are not required.

Bypass capacitors for the supply are also not mandatory since the circuit is powered directly from a lead-acid battery. Having said that, there is no reason why you should not change the circuit to tie pin 4 high, add a capacitor to pin 5 and so on.

In fact, RCS Radio Pty Ltd has produced an improved version of the published board which includes the modifications discussed here.

Noise & distortion in the graphic equalisers

Recently, I have become interested in building a pair of the 32-band graphic equalisers, as published in the March & April 1989 issues. When compared with the 20-band graphic equaliser published in August & September of the same year, I am somewhat confused as to why such similar circuits have quite different specifications. By this, I am referring particularly to the harmonic distortion and the signal-to-noise ratio figures.

There are several possibilities which may be contributors to the differing performance of the 32-band graphic equaliser: (1) the inclusion of 12 extra gyrators in each channel; (2) the use of metallised polyester capacitors, as opposed to the metallised polycarbonate capacitors specified in the 20-band graphic equaliser; (3) the master level control being placed in the signal path prior to the buffering action of IC1a, resulting in the input impedance and signal-to-noise ratio being affected by the position of the slider; (4) the PC board layout; and (5) the positioning of the power supply.

Could you please advise me if any of the above factors (or perhaps others) are contributors to the differences in harmonic distortion and signal-to-noise ratio between the two published equalisers, as I am keen to alter the circuit of the 32-band graphic equaliser in any way to obtain performance enhancement. (T. T., Newtown, Vic).

• The main reason why the 32-band equaliser has inferior performance to the 20-band unit is that it has 12 extra gyrators. The 32-band unit also had some gain following the buffer and if IC1a was changed to a voltage follower, as in the later design, a small improvement would probably occur.

The MK series capacitors were used in the later design because of the their consistent (smaller) size and lead pitch and also because they reputedly give slightly lower distortion. There is little that can be done to improve the 32-band circuit, given that it is much more complicated. **SC**

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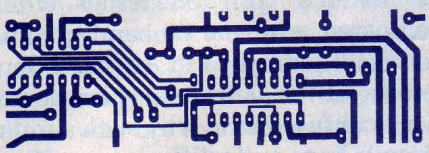

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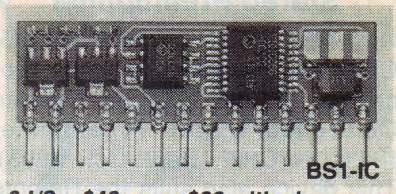

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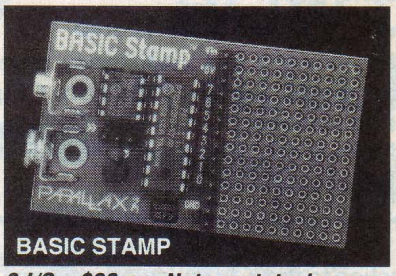

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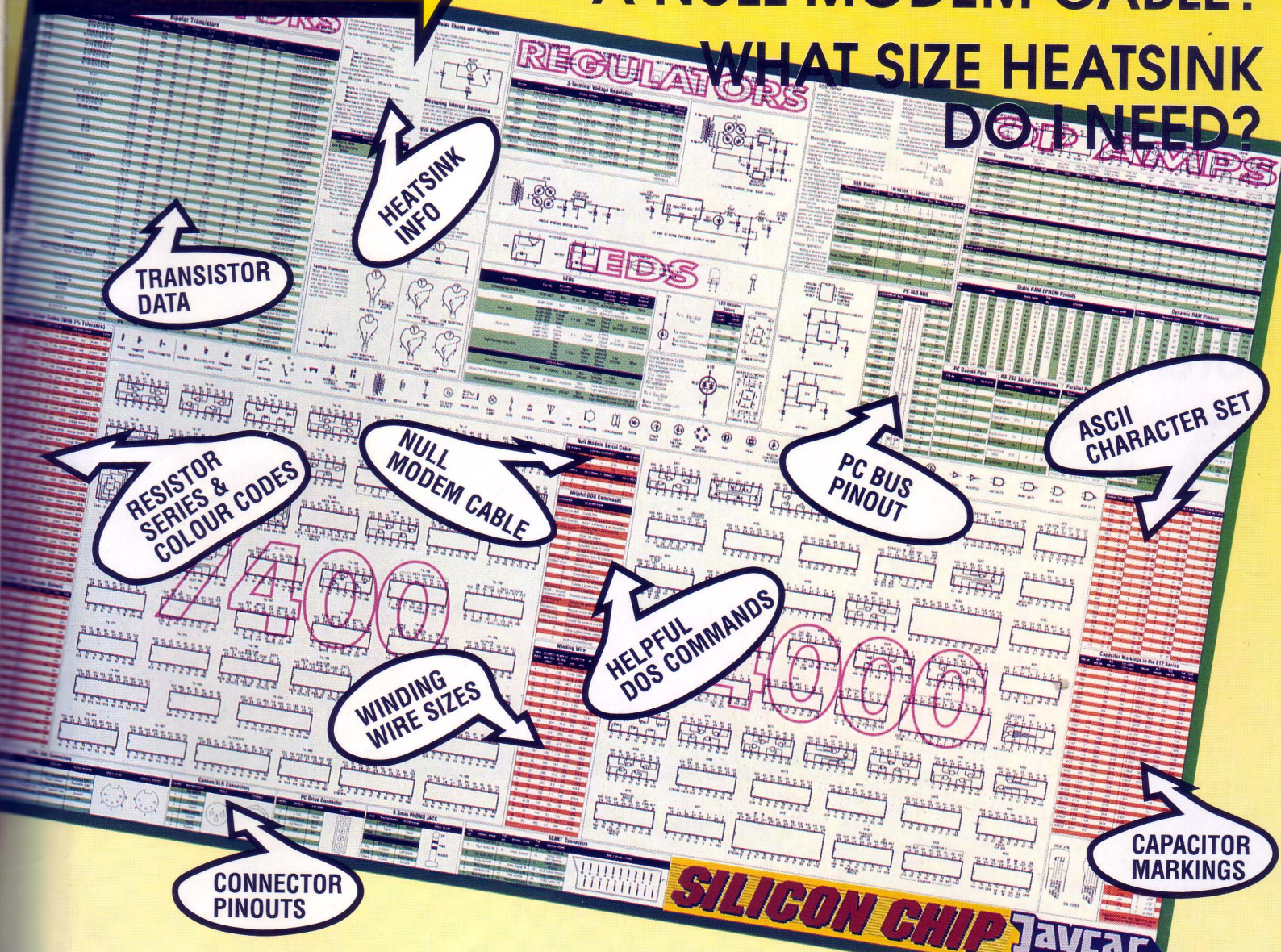

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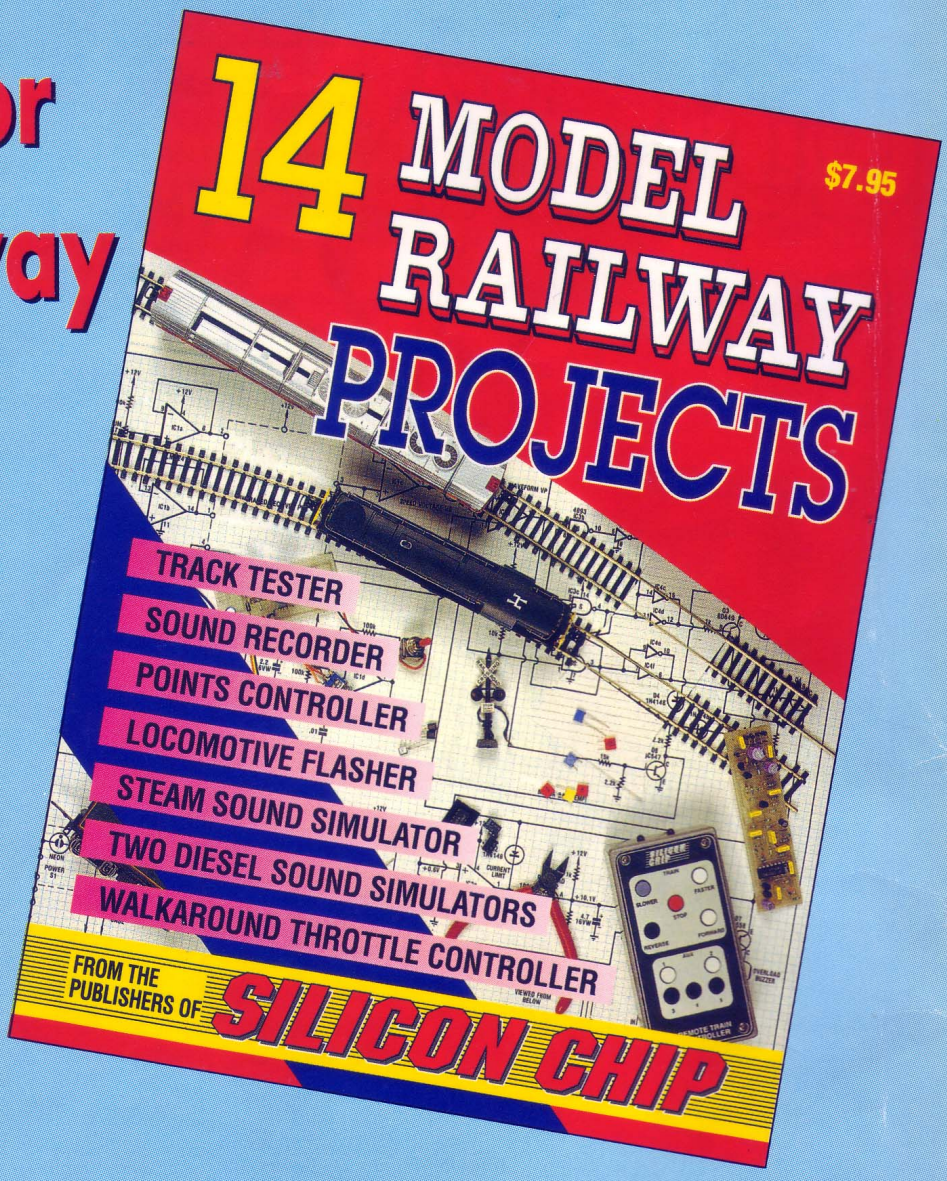

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